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Fire Management Notes

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Contents

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Cover: Fire lookout tower in Israel. See story on p. 34.

Fire Protection Project in China

Fred A. Fuchs

Assistant director, USDA Forest Service,
Fire and Aviation Management, Washington, DC

In May 1987, a huge fire burned 1,330,000 hectares (3,286,385 acres) in the northeastern part of the People's Republic of China, damaging 870,000 hectares (2,149,770 acres) of forest area, 10,081 homes in 3 towns, and much equipment.

The fire occurred in the Daxinganling Forest Area (DXAL) lying in the northwestern corner of northeast China and covering the most northerly parts of Heilongjiang Province and the Inner Mongolia Autonomous Region. This forest region is the largest resource of natural forest in China. It is separated from the Union of Soviet Socialist Republics on the north and east sides by the Heilongjiang (Amur) River and on the west side by a major tributary, the Ergun He. The region measures some 740 kilometers (460 mi) from south to north and ranges from 203 to 583 kilometers (125 to 360 mi) east to west. Its geographic coordinates are 47° to 53° north latitude and 119° to 127° east longitude.

The Fire Problem in the DXAL and its Importance

Forest fires are frequent and severe in China's forest areas. The DXAL has more frequent fire occurrence than any other part of China. Forest fire loss constitutes 20 to 25 percent of China's fire loss. From 1966 to 1986, there were 73 huge fires in Heilongjiang and Inner Mongolia or 80 percent of China's total number of huge fires. There were 7 huge fires with a burned area of more than 65,992 hectares (163,000 acres) each. The longest fire lasted 47 days. The most recent devastating fire started May 6, 1987, and lasted 28 days, blackening an area of 1,330,000 hectares (3,286,385 acres) and damaging a forest area of 870,000 hectares (2,149,740 acres). It was the most serious loss since the foundation of the People's Republic of China (1949).

China classifies fire in the four following ways (one sets the size limits for a warning fire; the other three for forest fires):

Size	*Classification*
Less than 1 ha	Warning fire
1–100 ha	Fire
100–1,000 ha	Big fire
1,000 ha or larger	Huge fire

In the DXAL, there are nearly 200 warning fires and 100 forest fires each year with a total burned area before 1980 of 150,000 hectares (370,500 acres), a forest damage rate of 0.9 percent, a much higher rate than in other areas in China. The burned timberland average is 1,300 hectares (3,200 acres) per fire. For example, before 1980, in the Songling and Yangshu Forestry Bureaus, huge fires broke out every 3 to 5 years. Now most of these two forestry bureaus have been changed into open forests and bared mountains with a forest coverage of only 10 to 20 percent.

The DXAL is often struck by lightning, causing 15 percent of the fires. In the northern forest area of the DXAL, 23 percent of the fires were caused by lightning. In the southern forest area of the DXAL, lightning fires usually occur between mid-May and June 10, while the northern forest area is struck mainly in late June.

The DXAL is the main timber base in China. Its current forest area is 10 percent of China's total forest, the standing volume 13 percent. It has a mean standing volume of 100 cubic meters (3,531 ft^3) per year. The dominant species, larch (*Larix gmelini*), constitutes 70 percent of the total standing volume; the second most common species or 19 percent of the total is white birch (*Betula* spp.). Scotch pine (*Pinus sylvestris* var. mongolica), oak (*Quercus* spp.), poplar (*Populus* spp.), spruce (*Picea koraiensis*), and others make up the remaining portion.

In recognition of the rising demand for forest products and the country's shrinking natural forest resources, the Chinese have embarked on a long-term program of forestry and forest industry development designed to make China self-sufficient in wood-based projects. The disastrous fires of May 1987 in Heilongjiang, the country's major source of industrial timber, have further exaggerated the already precarious situation of declining forest resources in which the country finds itself today. Since this region started its development, much work has been done, and some achievements in fire have been gained. However, the severe fire situation has not been essentially changed, resulting in a decline of the forest resource area because, on average, fires burn more forest acreage per year than is planted.

Climate and Land Features

The climate is continental cold-temperate, characterized by long, cold, dry winters and short, warm,

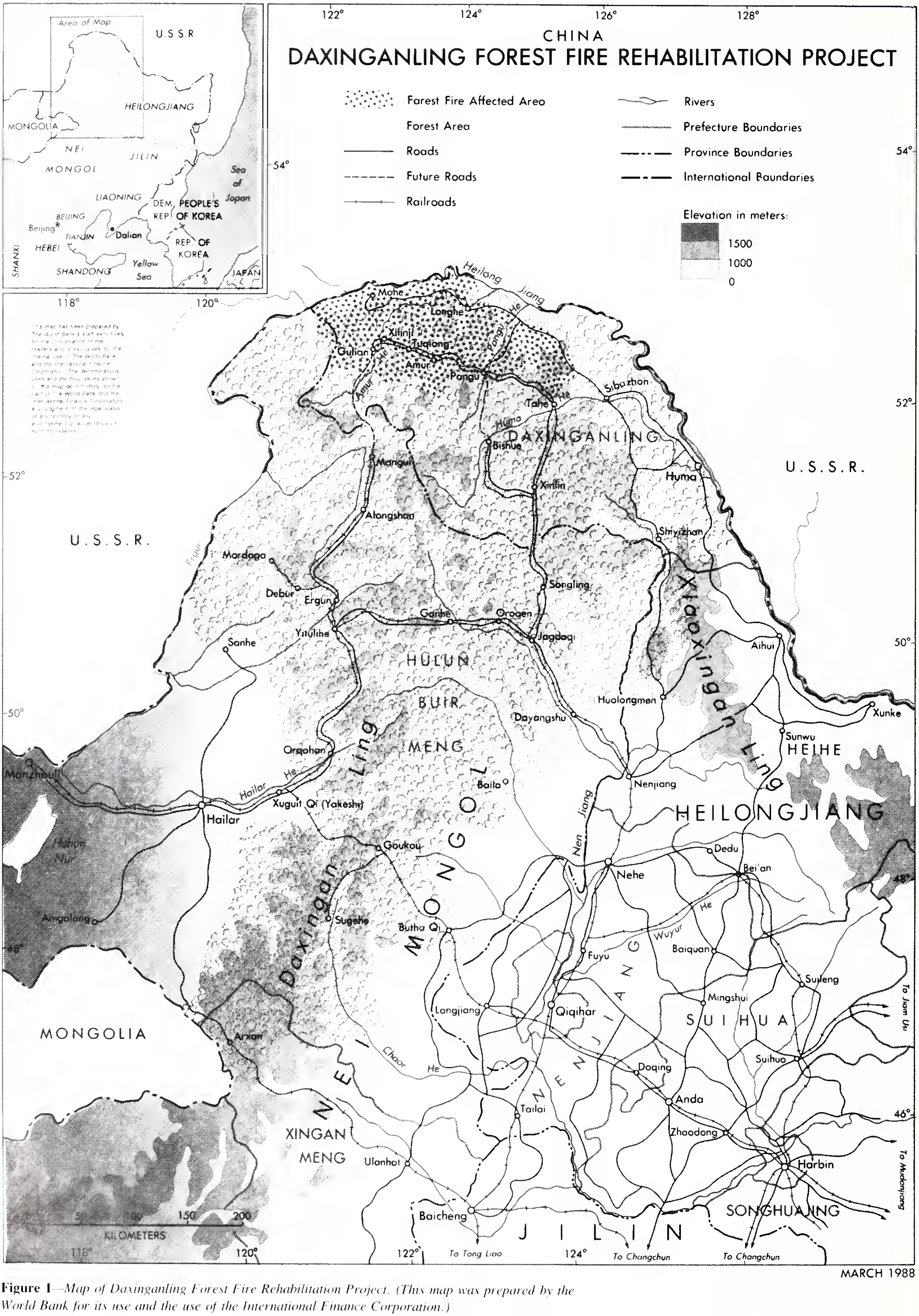

Figure 1—*Map of Daxinganling Forest Fire Rehabilitation Project. (This map was prepared by the World Bank for its use and the use of the International Finance Corporation.)*

humid summers. Mean annual temperatures vary from 0 to −6 °C (32 to 21 °F), with a minimum of −50 °C (−58 °F) and a maximum of 35 °C (95 °F). Frost-free days vary from 80 to 120 days per year and annual precipitation varies from 36 to 56 centimeters (14 to 22 in). It is dry and windy in spring because of the monsoon from Siberia, with a spring rainfall (from March to May) of only 2 centimeters (0.8 in) or 4 percent of annual precipitation. However, the average evaporation during the same period is 17 centimeters (6.7 in). From mid-April to mid-May, there are more than 10 days that the wind blows above Wind Force 5, with a peak of Force 7 to 8 winds (62 to 70 km/h or 38 to 43 mi/h) lasting 1 to 3 days. The Wind Force equivalents are as follows:

Wind Force 5	44 km/h (27 mi/h)
Wind Force 6	50 km/h (31 mi/h)
Wind Force 7	62 km/h (38 mi/h)
Wind Force 8	70 km/h (43 mi/h)

These winds are the main climatic element causing fire disasters in the DXAL. Since 1963, when the DXAL Forestry Corporation started its development of the forest area, 70 percent of the huge forest fires in Heilongjiang Province went out of control only because of the strong wind during those days.

The DXAL Forest Area is hilly land with a chain of mountains. The slopes are normally under 15°. There are 20 rivers in the area, all with shallow riverbeds and open grassland, usually 91 meters to 4 kilometers wide (300 ft to 2.5 mi), alongside the rivers. There is also much peat land with hammocks. Fire spreads rapidly in the grassland and causes severe damage.

The elevation of the rolling hills of the region ranges from 198 to 1,524 meters (650 to 5,000 ft) above mean sea level. The dominant soil types are the brown podsolic forest soils on the slopes grading into dark brown forest soils and hammock (bog) soils in the valley bottoms. Over 70 percent of the area is covered with shallow soils of 30 centimeters (12 in) or less depth.

Government Action and International Assistance

After the huge May 6 fire, leaders of the State Council and the Central Government are paying close attention to forest fire control. The State Council, in its report "On Dealing with the Huge Fire Disaster in the DXAL Forest Area," and the Standing Committee of the People's Congress in a resolution emphasized the importance of improving forest fire control facilities and increasing the ability for fire prevention and fire control. "We should invest some money in fire control," Vice Premier Tian Jiyuen pointed out clearly. "We should use **modern technology** to improve fire control ability."

The Government of China requested the International Bank for Reconstruction and Development (World Bank) to assist in the preparation and financing of a forest fire protection and rehabilitation project for the Heilongjiang Province. In response to China's request, the World Bank asked the U.S. Department of Agriculture Forest Service for assistance. I was loaned to the World Bank as a consultant for this project. The team consisted of Horst Wagner, team leader and World Bank senior forester; Bill Jones, World Bank senior economist; private consultants, Derek Paul, a silviculturist from England, and Karl Kehr, a logging and transport specialist from Germany; and me, Forest Service aerial suppression specialist.

Field Trip to Daxinganling Forest Area

The mission was scheduled for 3 weeks in October but due to visa delays was put off until the first 3 weeks of November. A mission in September or early October would have been much more productive, as November was far too cold and past the fall fire season. As a result, we did not meet the firefighting personnel we had hoped to meet nor did we see as much firefighting equipment or as many demonstrations of techniques as we wished.

On November 3, we began our field trip to the north, departing Beijing for Harbin by tri-jet, a 1.5-hour flight. There we met with the Heilongjiang Province Forestry Office personnel. That evening we boarded a train for a 14-hour ride to Jagdaqi. The Jagdaqi office is similar to a Forest Service regional office; it has eight Forest Bureaus (similar to National Forests) in two counties.

In Tahe County, we visited the Tahe and Amur Forest Bureaus. In Mohe County we visited the Tuqiang and Xilinji Forest Bureaus. Jagdaqi to Tahe by train took 6½ hours; Tahe

to Amur by vehicle, 5½ hours; Amur to Tuqiang by vehicle, 1½ hours; and Tuqiang to Xilinji by vehicle, 2 hours.

This took us through some of the fire area and destruction from the May fires that wiped out three towns where forestry bureaus' headquarters were located. The fire also damaged 9 forest farms, 5 woodyards, 695 kilometers (429 mi) of utility line, 382 kilometers (236 mi) of powerlines, and 15 kilometers (9.6 mi) of railway. Two thousand five hundred twenty-eight pieces of equipment were ruined, which included 62 large items such as trucks, tractors, bulldozers, and winches. Fifty-six thousand people lost their homes, estimated as a $56 million loss.

Amur and Tuqiang were two of the cities of nearly 20,000 population that were almost totally destroyed. However, most of the housing has been rebuilt and most of the families are in new homes—a very impressive reconstruction program.

Equipment in Current Use

Currently, the DXAL is using aircraft for helitack and aerial detection. Aerial detection is accomplished using 10 to 12 Transport 5's (T-5's) and 7 Mi-8 helicopters. The T-5 is a single-engine, all-metal cabin biplane of Russian design and built in China. It is powered by a 9-cylinder radial engine, has an inward opening door, and can seat up to 12 passengers. This is the same aircraft that the Russians use as a smokejumper platform. The Mi-8 is a twin-turbine, single-rotor helicopter of Russian design built in China. It can carry up to 25 passengers or 18 firefighters and has rear-opening clamshell doors.

Suppression is accomplished mostly by direct attack with a variety of tools such as blowers, branches, swatters, backpack pumps, and miscellaneous handtools. The average fire size at detection is 61 hectares (150 acres) and attack times are sometimes slow. Many valley bottoms are swampy, making travel difficult in areas of the forest bureaus that have not been roaded. The Mi-8 helicopter is also used to deliver 18 firefighters, but the helicopter is slow and very large. Its large size makes finding suitable landing sites difficult and often quite some distance from the fire, requiring the firefighters to walk a considerable distance.

Our field trip took us within about 32 kilometers (20 miles) of the Russian border and into very cold weather. Several nights were −38 °C (−37 °F), with daytime highs of −28 °C (−20 °F). And it wasn't winter yet!

The buildings were only slightly heated—just enough to keep water pipes from freezing. Meeting and dining rooms were only heated from 1.7 to 4.4 °C (35 to 40 °F). They do build homes, offices, and hotels with good passive solar designs: brick walls 31 to 40.6 centimeters (12 to 16 in) thick, double windows with 15 centimeters (6 in) airspace between panes, and concrete floors (no carpet) to absorb the daytime solar heat. All the rooms face south with hallways on the north side.

MI-8 Russian-designed helicopter used by the Chinese for helitack, aerial detection, and transportation of smokejumpers.

Transport 5 (T-5) Russian-designed airplane used by the Chinese for aerial detection and transportation of smokejumpers.

The hotels did not usually turn on the hot water heaters. However, some of the hotels where we stayed would turn on the hot water for one-half hour in the evenings just so the Westerners could take a hot bath. Sometimes it pays to be pampered!

Development of the DXAL started 22 years ago and the average fire loss is 179,996 hectares (444,770 acres). This exceeds the current reforestation efforts and results in a continuing decline of forest resources.

Investments in fire protection during this period have not been adequate to reduce the fire loss effectively on an overall average. As stated earlier, the major losses occur on days of extremely high wind in the early spring, usually a very dry and windy season that follows a dry winter weather pattern. This condition lasts until the summer rains arrive in late June.

New Fire Program Objectives

In February, the team returned to China for 2 weeks to complete its part in the project. Horst Wagner, Karl Kehr, and I, members of the first team, were joined by Jim Douglas, Australian forest economist and private consultant, and Ulf Kihlblom, Swedish remote sensing specialist in private industry. These 2 weeks were spent entirely in Beijing developing and negotiating the final project.

The project increases investment by $50 million in fire protection, with detection airplanes, helicopters, retardant bombers, ground vehicles, communications equipment, weather and fire forecasting equipment, lightning detection systems, improved fire suppression techniques, study tours, and training.

The objectives of the project are as follows:

- Cover the area by aerial detection once or twice a day instead of the current once in 2 days.
- Reduce fire size at detection from 60 hectares (150 acres) to less than 2 hectares (5 acres).
- Transport firefighting crews by helicopter to the fire site within 2 hours.
- Transport firefighting crews by ground vehicles to the fire site within 3 hours.
- Suppress fires of less than 100 hectares (250 acres) 90 percent of the time.
- Control forest fire damage to under 0.3 percent annually.
- Reduce average annual burned area from 180,000 hectares (444,770 acres) to 30,000 hectares (74,130 acres).

The potential for huge fires and excessive fire losses will continue during the 1988 and 1989 fire seasons. During the 1988 fire season, planning, study tours, and start of equipment purchasing will take place. During the 1989 fire season, equipment will be delivered, crews trained, and experience gained in fire management. Full benefits of the improved fire protection program will be in effect for the 1990 fire season, meeting the project objectives. ■

Downbursts and Wildland Fires: A Dangerous Combination

Donald A. Haines

Principal research meteorologist, USDA Forest Service, North Central Forest Experiment Station, East Lansing, MI

On June 8, 1981, a wildland fire on Merritt Island, FL, suddenly changed directions, killing two firefighters. On August 2, 1985, Delta Flight 191 crashed and burned while attempting to land at Dallas-Fort Worth Airport. These two events had one common theme, strong thunderstorm downbursts.

Introduction

It happens to most firefighters sooner or later if they have been on the job long enough. Everything along the fireline seems fairly well controlled. But then, unexpectedly, the wind shifts and becomes erratic. Wind speed picks up dramatically for 5 to 15 minutes and then decreases.

Another factor is added to the high winds: Precipitation ranging from very light to very heavy. It may fall so hard during a thunderstorm that it puts out the fire, or it may evaporate before it hits the ground.

With a change in weather comes a change in fire behavior—this time for the worse. The fire changes direction, previously controlled lines are lost, and a routine operation becomes life threatening. What happened?

Definition

The odds are high that the weather event described in the introduction was a downburst. A downburst is a downdraft associated with a thunderstorm or other well-developed cumulus clouds that induces an outburst of damaging winds on or near the ground. When the burst is small (0.4–4 km or 0.25–2.5 mi in diameter), it is a microburst; larger ones (more than 6.5 km or 2.5 mi in diameter) are macrobursts. Not all downdrafts are downbursts. Fujita *(4)* stated that horizontal wind speeds generally exceed 40 miles per hour (104 km/h) on the ground in a true downburst. Although Schroeder and Buck *(7)* discussed downdrafts in their 1970 handbook, *Fire Weather*, recent research has greatly increased our knowledge of downburst occurrence and structure. Because a downburst can cause dramatic and dangerous fire behavior, firefighters should understand this phenomenon.

Downbursts are classed as either dry or wet. Most investigators believe that both types require raindrops as an initial condition because evaporation of these drops cools the air, which then falls as it gets heavier. Humid areas, like the Southeastern United States (where the downdraft is almost always associated with moderate to heavy rain), usually experience wet downbursts. The wet downburst produces a core of rain that is visible, although it may be obscured by associated weather.

Dry downbursts occur in more arid places like Colorado when cloud bases are higher and precipitation evaporates before the downdraft reaches the ground *(6)*. The dry downburst might not be seen easily by either radar or observers in such cases. Both cumulonimbus clouds as well as less fully developed rain clouds can produce them.

During a study of microbursts in the Denver area, Fujita and Wakimoto *(5)* found that 81 percent were the dry type. Little or no rain fell to the surface with them. In contrast, during an Oklahoma study, Eilts and Doviak *(3)* found that the macrobursts detected on their radar were imbedded in intense convective storms and had large, heavy rain cores. But, these differences in detection may be the result of scanning strategies used with the different radar units *(3)*. In particular, the Oklahoma radar may have missed lighter rain cores.

Sherman *(8)* concluded that with the falling dense air in a downburst, the flow behaves like a toroidal vortex. In other words, as the vortex at the head of a downburst approaches the ground, each element of the falling vortex moves downward and outward along a roughly hyperbolic path. Near the cloud base, winds and rain converge around the descending air, feeding into it. A sharp observer might be able to spot the developing downburst if it is outlined by rain because the precipitation falls rapidly, reaching a downward velocity of 65 miles per hour (105 km/h).

When flying directly beneath a microburst, a pilot in a spotter plane will find that the difference between the headwind and the tailwind is typically 60 miles per hour (97 km/h) as the winds spill out horizontally to either side of the parent cloud. Fujita showed that in one case this difference exceeded 172 miles per hour (279 km/h).

Several researchers have found a relationship between an observed temperature drop at surface and the increased wind speed. The larger the temperature change, the more severe the wind gusts. The leading edge of

the horizontal movement of the wind gusts is called a gust front. As it spreads horizontally, the gust front may develop as an expanding fluid structure many miles long, depending on the strength of the downburst (fig. 1).

A Tragic Example

The weather that occurred with the 1981 Florida wildland fire seems to have been a classical downburst *(1)*. Two men, operating a dozer and plow, attempted containment along the eastern flank of the Ransom Road Fire. A thunderstorm developed and winds abruptly changed from south to west. In response, the head of the fire changed from north to east, and the flames overtook the two men. A tower with a recording anemometer to the northeast of the fire area showed wind speeds increasing from an average of 7 to 25 miles per hour (11 to 41 km/h) with gusts to 52 miles per hour (84 km/h). Within 10 minutes, the temperature fell from 82 to 60 °F (28–16 °C). The tower readings ended at that point as lightning hit it.

This then was a true wet-core downburst as "a heavy rainstorm, accompanied by thunder and lightning, descended on the fire area, lasting for 15 to 20 minutes and just about completely extinguished the wildfire" *(1)*.

Forecast Possibilities

Although wet downbursts are difficult to forecast, downbursts in a dry environment can be predicted from morning upper-air soundings.

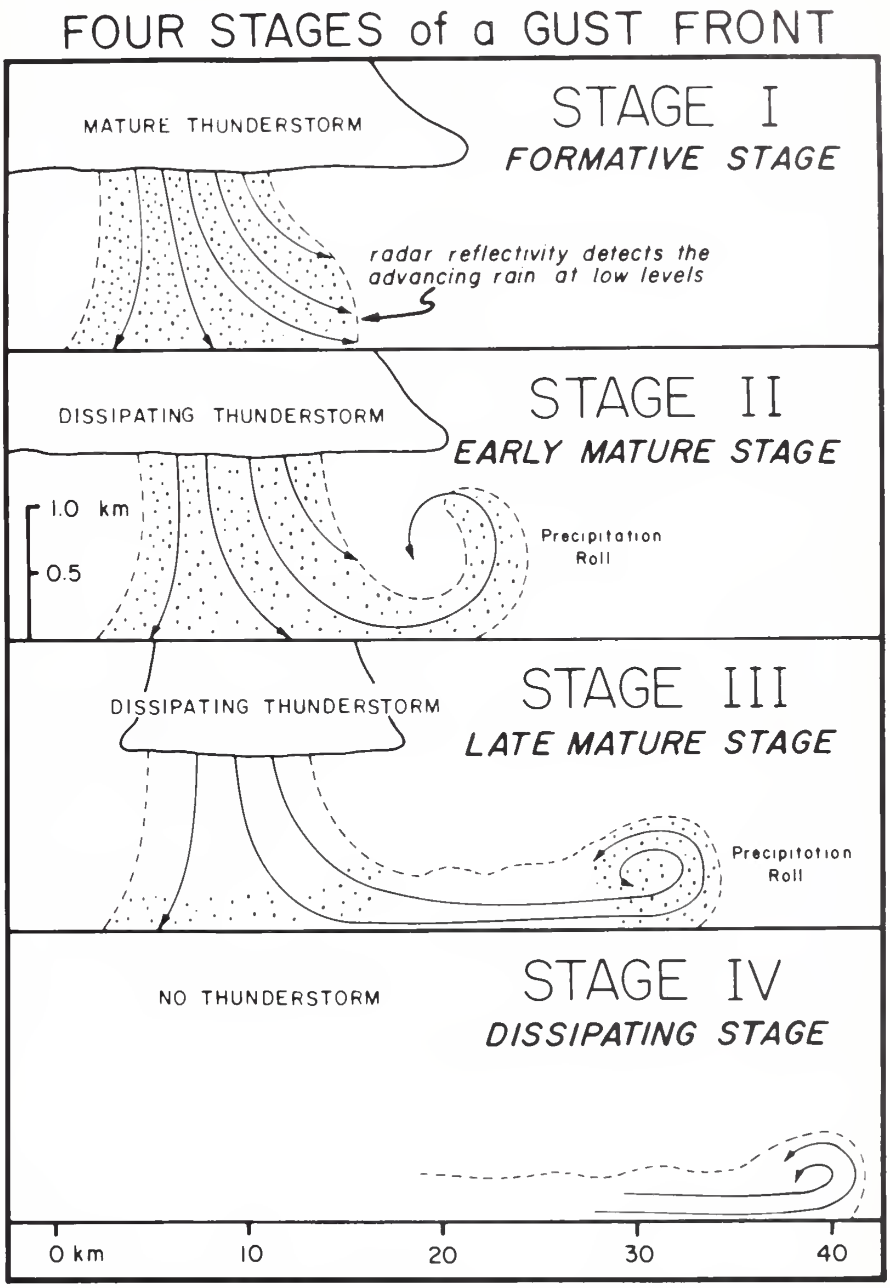

Figure 1—*The four stages of a thunderstorm downburst and gust front. The precipitation roll is a horizontal roll vortex formed by airflow that is deflected upward by the ground. Note the changes in wind direction as the gust front passes a point and moves on (9).*

According to Caracena and Maier, "inroads have already been made into the microburst forecast problem in understanding the dry end of the convective spectrum where the concept of severe weather is extended to conditions that favor strong downdrafts from high base cumulonimbi" *(2)*. They believe that to be able to forecast downbursts in all parts of the United States, meteorologists must first understand how nature generates them over the entire range from wet to dry extremes. Forecasters then could diagnose typical downburst conditions from the daily upper-air data.

Conclusions

Even though research is taking the surprise out of the dry downburst, forecasting the wet downburst will be a difficult problem for some time to come. Predicting the impressive winds that accompany these downbursts remains an elusive goal. Accordingly, the Board of Inquiry for the Ransom Road Fire aimed recommendations at the field level. The Board felt that an observer in a spotter plane in direct contact with the line crews could have anticipated the weather conditions and, hence, fire behavior changes. This could have allowed directions for an escape route. The Board also suggested that crews pull back from the fire during impending thunderstorms in areas with fuels that burn with high intensity and rate of spread, as in the Ransom Road Fire. ■

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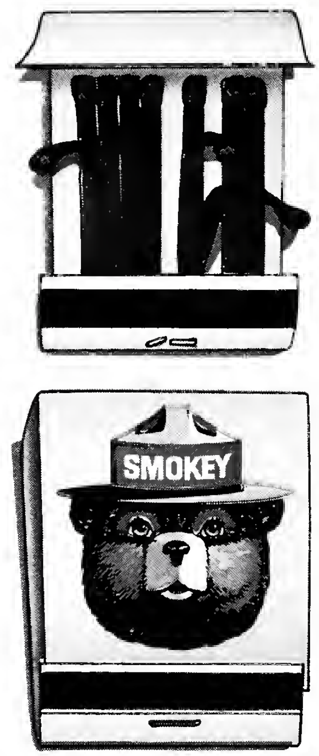

Celebrity Wildfire Prevention

Maynard Stoddard

Assistant chief, Virginia Department of Forestry, Forest Fire Control, Charlottesville, VA

VIRGINIA DEPARTMENT OF FORESTRY

In 1984, the Virginia Department of Forestry began a unique wildfire prevention campaign. Nationally known entertainers and Smokey Bear were featured in a publicity campaign using a series of wildfire prevention posters published by the Department for distribution throughout Virginia.

Cathy Baker of the Nashville "Hee Haw" television program, the Statler Brothers, Roy Clark, Ernest and Tova Borgnine, Sawyer Brown, Willard Scott of NBC's "Today" show, and Ray Charles were among the entertainers who were photographed with Smokey.

Since the campaign started, two new posters have been issued each year and distributed at the beginning of the spring and fall fire seasons. The posters have been displayed in a variety of businesses, such as country stores, music centers, restaurants, and banks. To keep the public's attention directed toward fire prevention, the poster displays have been changed every few months. Each poster change featured a different entertainer posing with Smokey and a different fire prevention message. Ten poster issues have been produced, and 2,500 posters of each celebrity-Smokey Bear poster issue distributed.

For the Department's 1988 wallet calendar, Grandpa Jones of "Hee Haw" and Smokey were photographed together during Smokey's week-long visit to the "Hee Haw" set and the Grand Ole Opry in Nashville, Tennessee. The Tennessee Division of Forestry worked with the Department at the Nashville filming.

To continue the celebrity-Smokey Bear fire prevention campaign, the Department has issued an $8\frac{1}{2}$- by 11-inch lightweight, cardboard calendar with a color photograph of Smokey and the Oak Ridge Boys. The reverse side of the calendar includes information useful to students—tables of weights and measures and geometric figures with formulas to compute area, perimeter, and circumference. These calendars, which also have a wildfire prevention message, will be distributed to Virginia middle and high school students.

Interest shown by the public, the cooperativeness of businesses who allowed the posters to be displayed, and the number of requests for the posters show that this has been an effective way to present the wildfire prevention story to the public.

The entertainers who participated in this program were contacted through their public relations representatives and agents and sometimes directly. All were cooperative and interested. They considered it a public service and received no payment for their participation.

Fire prevention publicity during the next few years will concentrate on the upper school calendar cards with a photograph of Smokey and nationally known entertainers like those who have already participated and rock groups. ■

The Statler Brothers working with Smokey Bear in fire prevention program.

Georgia's Fire Simulator

John R. Burns, Jr.

Training program director, Georgia Forestry Commission, Macon, GA

"5 Yankee (fixed-wing aircraft) to Hampton 1 (fire boss). Hampton 1, I don't see any activity around Hampton 72. The fire has burned over the tractor, and I don't imagine the operator survived—no fire shelter is visible."

"Hampton 1, copy. I'll send a rescue team into the area."

Forest firefighters hope they will never have to engage in that kind of apprehensive conversation, but those that are experienced in firefighting know that such a tragedy can happen when you're dealing with something as stubborn and unpredictable as fire!

The Need for Improved Training

With the growth of the urban-interface problem from coast to coast, wildland fire suppression has become more difficult and the frequency of life-threatening situations to firefighters has greatly increased. Large-scale wildland fires that often occur on the West Coast are not commonplace in the Southern states. However, to help prepare firefighters for high-risk situations, the Georgia Forestry Commission has devised a modern fire simulator so realistic that comments from students include statements such as, "All you need to add is the smoke!" Since the first class of firefighters was introduced to the simulator in December 1985, more than 500 State and forest industry personnel have been trained and tested in fire suppression tactics.

How the Fire Simulator Training Works

The main objective of the simulator is to give the student fire boss "fireline" experience in a classroom setting. The system gives the student the opportunity of reacting in practice as he or she might react on an actual fire.

Information Available to Students. Anything that would be readily available to the student in the normal work area can be used during this exercise. The student can request and receive assistance from law enforcement groups, area fire departments, local emergency medical services, or other agencies that may be needed to get the job done.

In addition to those capabilities, the student can change location on the fire at any time. Strategically sound moves result in additional information being provided about the fire. The amount of information supplied depends on the advisability of the move.

In Georgia, the county forest ranger (supervisor) is responsible for the suppression of all woodland and brush fires within his or her jurisdiction. Upon arrival on such a fire, the county forest ranger has two primary items with which to start planning fire suppression activities. These include a county grid map and a two-way radio. In the fire simulator, this and some fire weather information is all the student is given to start the exercise. No aerial view of the fire is provided as in other simulators. The student must depend on aircraft and ground crews to provide information concerning the fire's behavior, terrain, fuel types, and potential problems lying ahead.

The Student Fire Boss. The students, usually five, are located in a room by themselves with maps of the fire area and two hand-held radios. A fire boss is selected to begin the exercise. Periodically, each student is given this responsibility. The fire problem continues to exist as the position is shifted from one to the other. Each trainee is expected to assume responsibility for fire activities as they exist when he or she takes over. Each student must pay close attention and be aware of what is going on at all times.

The Team Role Players. In a room separated from the students (the

war room), a team of role players is assembled with maps, radio, and tape recorders. They are experienced fire management personnel playing the role of pilots, tower operators, fire department personnel, truck and tractor operators, and others. The sincere manner in which they play their roles and the proper use of sound effects, such as trucks, tractors, aircraft, and fire department equipment, create the atmosphere needed to make the problem realistic. The role players are the backbone of the fire simulator training. This group, the trainees, and all activities related to the fire are the responsibility of the team leader.

Periodically, the leader will check with the student fire boss to be sure that he or she has not become confused or frustrated to the point of not being able to function in that leadership role. If this happens during the exercise, the training is stopped and the student is brought up to date on the fire activities and equipment location. After this has been done, the exercise picks up where it left off. The problem runs for a specified time period and is concluded after that period has elapsed whether the fire is contained or not.

During the exercise, the students have been presented a very difficult fire situation in an accelerated timeframe. While in the simulator, the student must decide where to place fire suppression crews, obtain backup units, provide assistance for fireline injuries, handle mechanical failures, and attempt to solve many other problems that arise on an actual fire. One of the more stressful aspects of the exercise is the continuous radio traffic common on high-fire danger days. One consistent observation has been that students who do well in the simulator perform well in the field.

The simulator is not a script-type exercise. It is operated on a reactive basis. The team leader provides the student with a scenario of the problem and a weather forecast before the exercise starts. The scenario informs the student of the location and starting time of the fire, arrival point at the scene, and the situation discovered upon arrival. The team leader will start radio communications several minutes before the student becomes acclimated to the problem. Once the problem begins, the role players react to the student's commands. The fire progresses at a rate consistent with the type of fuel, weather, and topography in the problem area.

The Review. At the end of the exercise, the students are brought into the war room and given a critique of their performance by the team leader. By observing the operations map, the students see exactly where the fire burned, what is consumed, and where firelines and equipment are located.

The uniqueness of the simulator is that the student operates from a real-life perspective. The student must operate in the simulator as at the scene of a fire. The primary goal of the exercise is not that the fire be contained, but to teach the skills of initial attack, strategy, fire organization, and operations. The simulator can be adapted for use under any system, whether it is the old "Large Fire Organization" or the newer

National Interagency Incident Management System (NIIMS) approach. It can be used to train overhead teams, fire chiefs, forest industry personnel, or multistate fire organizations.

Currently, the Georgia Forestry Commission is working with the State of Florida to develop a simulator problem depicting a major fire on their common border.

The most common statement heard from those who have completed this course is this: "It is the closest anyone could come without actually being on a fire."

Video tapes are available that give a brief, but complete view, of the simulator in action. Contact John R. Burns, Jr., Training Program Director, Georgia Forestry Commission, P.O. Box 819, Macon, GA 31298-4599, Telephone (912) 744-3259. ■

Interagency Regional Training Groups

James B. Whitson

Cooperative fire protection manager, Florida Division of Forestry, Tallahassee, FL

With the advent of the National Interagency Incident Management System (NIIMS), wildland fire protection agencies have entered into cooperative training efforts at the regional and local level. Groups have formed to develop materials and train with those who have similar problems and interests. In addition, the new Wildland/Urban Fire Protection Initiative is incorporating structural fire protection agencies into these groups and strengthening them even more.

To better coordinate and communicate with these groups, the National Wildfire Coordinating Group (NWCG) Training Working Team (TWT) has designed and implemented a procedure to do this. The following outlines this procedure.

Background

In October 1975, the NWCG established the TWT for the purpose of developing and coordinating fire management training programs for Federal, State, and local fire protection agencies. For the past several years, the TWT has encouraged the formation of interagency training groups within geographical regions. Such groups, where established, have demonstrated an increase in the interagency sharing of training resources and the development, planning, and scheduling of training courses to meet needs of agencies within the region. They have also provided assistance to the TWT in completing training development work of national need and priority.

At its July 1987 meeting, the TWT discussed ways to recognize and support such groups formally and further encourage their establishment in additional regions. Such an action

Wildland Fire Training Officers' Conference—1988

The 1988 Wildland Fire Training Officers' Conference, entitled "Back to the Future," was held in Boise, ID, at the Training Center at the Boise Interagency Fire Center (BIFC) on January 25–28, 1988. The staff of the BIFC performed superbly in planning and executing the conference. Leaders of the Conference and agency directors commended organizers and facilitators for the fine work they had done.

The Incident Command System was used in organizing and carrying out the conference. Conference Incident Commander, Frank Boden, and Operations Section Chief, Bob Webber, of the U.S. Department of the Interior, the Bureau of Indian Affairs and Bureau of Land Management, respectively, led the conference.

Over 139 participants received up-to-date information on training techniques, philosophies, participant roles, and other topics important to training in wildland firefighting. ■

Conference Organizers: (Back row, left to right) *Amos Davis, Jan Henderson, Frank Boden, Arnold Hartigan, Don Willis, Lamar St. John;* (middle row, left to right) *John Block, Boyd Wiles, Laurel Simos, Nina Walken, Shari Hanel, Dick Terry;* (front row, left to right) *Patti Webber, Mike Utecht, Stan Palmer, Ruby Heisey, Rita Gates, and Bob Webber.*

would benefit interagency fire training cooperation within the regional areas as well as nationally in these ways:

- Provide a more effective exchange of information and training needs among regional areas and the TWT.
- Provide a pool of qualified people and resources to accomplish national interagency training development work.

Procedure

The TWT will actively support the formation and function of Interagency Regional Training Groups by expanding their role and encouraging participation at TWT meetings and conferences. Each group is encouraged to select a representative to serve as liaison with the TWT. Representatives serving as liaison will be invited to TWT meetings individually or as a group. Each will be a nonvoting but active participant. Each group will provide travel costs for its liaison to attend one or more TWT meetings each year.

The TWT is fully committed to supporting Interagency Regional Training Groups, for they provide a primary means and resource to accomplish its purpose. ■

Two Wisconsin Fire Specialists Honored

Two Wisconsin Department of Natural Resources' employees have received awards for their efforts in preventing wildfires.

James Miller, a forest fire staff specialist stationed at Rhinelander, WI, received the Golden Smokey Award for developing methods that have reduced the number of wildfires caused by railroads. Many of the procedures developed by Miller have been implemented nationwide. He also assisted in the development of a cost-efficient locomotive spark arrester. Previous winners of the Golden Smokey Bear statuette include the Lassie television series and Walt Disney.

David Sleight, a fire control assistant in Mercer, WI, received a Smokey Bear citation for his work in forest fire prevention over the past 15 years. Sleight helped develop county fair displays and parade floats. He also worked extensively with grade school educators developing forest fire prevention programs for the classroom. Sleight also resurrected the nation's first Smokey Bear suit (circa 1950) and designed a display case for it.

The awards were presented at the 21st annual meeting of Northeast Forest Fire Supervisors held in Brookfield, WI. ■

James Miller of Rhinelander, WI, with Golden Smokey Award.

David Sleight of Mercer, WI, with Smokey Bear citation.

Estimating Slope for Predicting Fire Behavior

Patricia L. Andrews

Mathematician, USDA Forest Service, Intermountain Research Station, Fire Sciences Laboratory, Missoula, MT

When predicting fire behavior in the field, it is desirable to be able to obtain the required input information with a minimum of special equipment. This article tells how to estimate slope (percent) using materials in a belt weather kit. This method can be used on wildfires by fire behavior analysts, field observers, and strike team leaders. Those who are monitoring fires that are not receiving full suppression action, such as prescribed fires in wilderness, will find it especially useful.

To predict fire behavior, a fire specialist must supply values for fuel model, fuel moisture, windspeed, and slope. Calculations can be done using tables, nomograms, calculators, or computer programs *(1)*. As described by Rothermel in "How to Predict the Spread and Intensity of Forest and Range Fires" *(2)*, fuels are classified as a particular fuel model by observation *(3)*; windspeed is measured; live fuel moisture is estimated by the state of curing; dead fuel moisture is determined by an estimate of shade and measurements of temperature and relative humidity; and slope is determined from a topographic map, estimated, or measured with an instrument such as a clinometer. Slope can also be estimated with adequate precision using the method described here.

Figure 1 illustrates the effect of slope on predicted flame length for four fuel models: 4-chaparral; 13-heavy logging slash; 2-timber litter and understory; and 9-hardwood litter. In this example there is no wind, dead fuel moisture is 6 percent, and live fuel moisture is 100 percent. Calculations were done using BEHAVE *(4)*. A resolution of less than 5 percent is clearly not necessary, especially when all of the other uncertainties involved in fire behavior prediction are taken into account. On the other hand, the value for percent slope has enough influence that a poor estimate may lead to a significant over or under prediction.

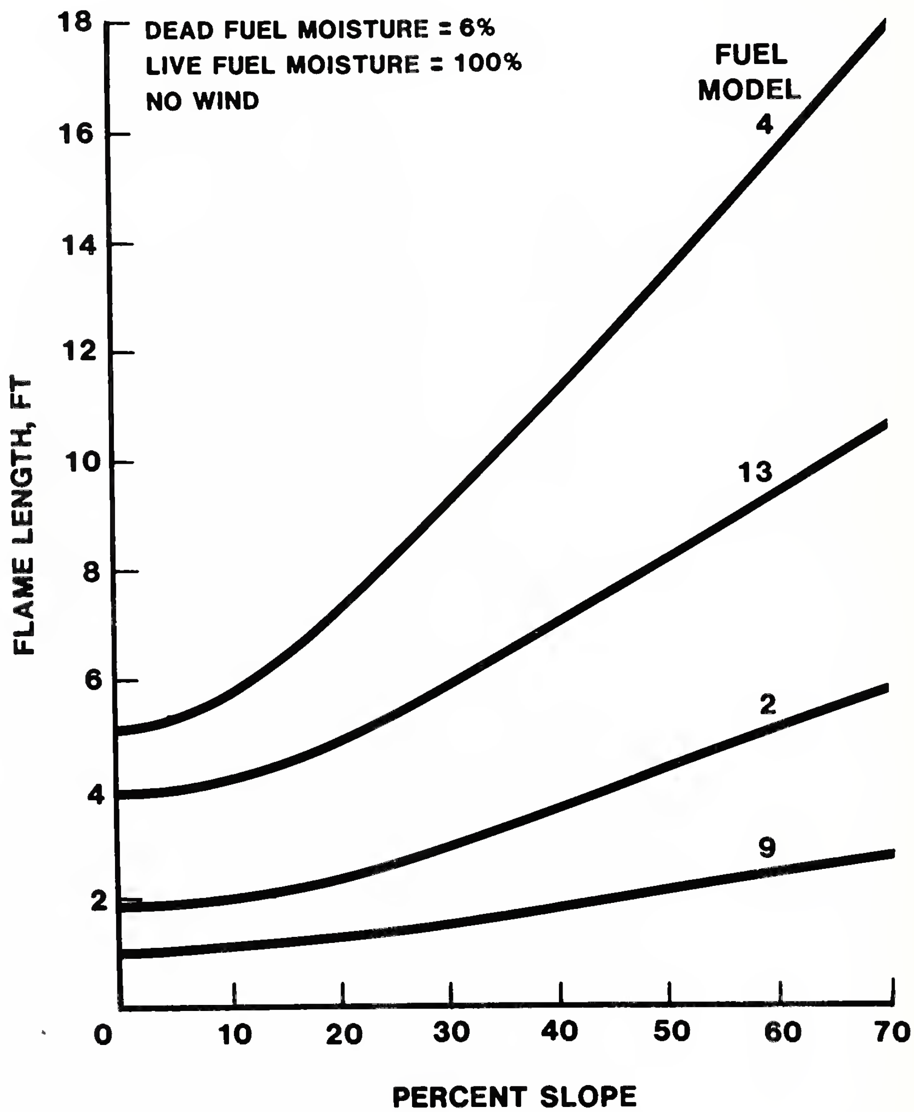

Figure 1—*The influence of slope on calculated flame length is shown for four fuel models under constant wind and fuel moisture conditions.*

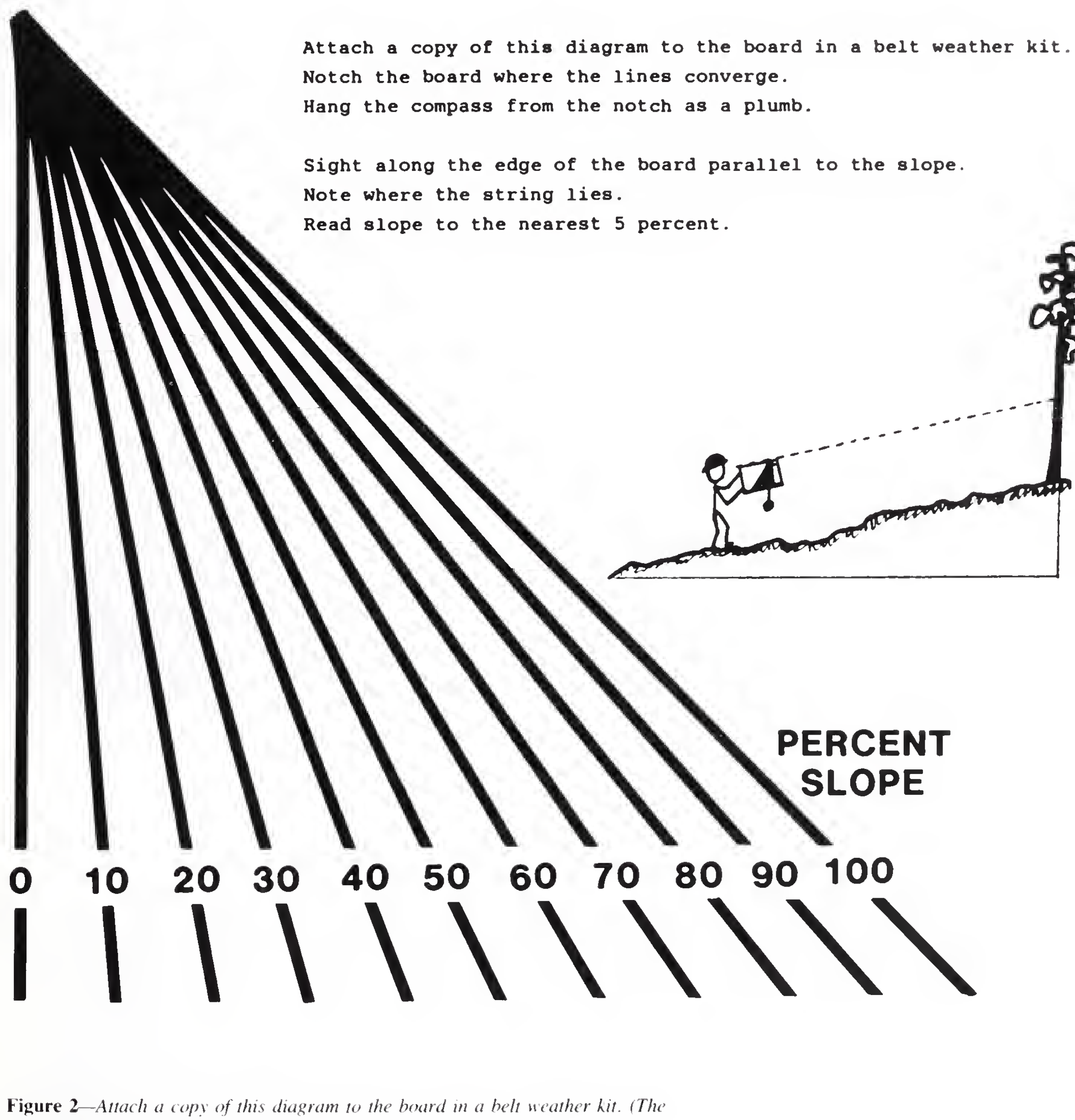

Figure 2—*Attach a copy of this diagram to the board in a belt weather kit. (The slight distortion caused by copying is unimportant.) Notch the board where the lines converge. Hang the compass from the notch as a plumb.*

The lines in figure 2 represent slope percentages from 0 to 100. Using a sheet of adhesive acetate, attach a copy of figure 2 to the board in a belt weather kit. Notch the board where the lines converge. Hang the compass by its neckstring at the notch to serve as a plumb. Sight along the board parallel to the slope, as shown in figure 3. Noting where the string lies, read the slope to the nearest 5 percent.

This method of estimating slope is a simple, no-cost alternative to eyeball estimates, which are notoriously poor, and to instruments such as clinometers, which are expensive and give a level of resolution not required for fire behavior prediction. ■

Figure 3—*Sight along the edge of the board parallel to the slope. Read slope to the nearest 5 percent. (Turn the board around to sight downhill.)*

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Railroad Fire Prevention Course

James Miller

Forest fire staff specialist, Wisconsin Department of Natural Resources, Rhinelander, WI

In 1978, the Northeastern Area State and Private Forestry entered into an Intergovernmental Personnel Act agreement (IPA) with the Wisconsin Department of Natural Resources for a 2-year study of the railroad-caused forest fire problem in the 20 States in the Area. The need for this study had been identified by the Northeast Forest Fire Supervisors (NFFS).

The study found that there was a need to develop a railroad fire prevention training course to provide forest fire prevention personnel with the basic tools for dealing with the problem. In 1980, the National Association of State Foresters' (NASF) Railroad Fire Prevention Committee addressed this need in a resolution. In addition, the Fire Prevention Working Team (FPWT) recommended the development of the training course to its parent group, the National Wildfire Coordinating Group (NWCG). The NWCG, however, concluded that the need to train for and implement the Incident Command System was more urgent than the development of a railroad fire prevention training course and, consequently, the training course was given low priority.

Course Goals, Standards, and Funding

At its 1983 meeting in Hyannis, MA, the NFFS voted to underwrite the cost of developing a railroad fire prevention training program of a quality that would meet its needs and at the same time be usable at the national level. The team chairman was selected and authorized to choose individuals from anywhere in the United States who he thought would be able to help carry this project to completion. The NFFS required that the course be written to NWCG standards, that it be usable by all members of the forest fire management community, and that it be up to date. Arrangements were made for the State of Indiana's forest fire control coordinator to administer the funding out of the NFFS Motion Picture Development Fund.

The Development Team

The team assembled to develop the course consisted of Roger Fitch, fire prevention engineer of the Union Pacific Railroad; John Graff, forest fire supervisor for the Commonwealth of Virginia; Ernest Halley, Chicago and North Western Transportation Company; Russ Johnson, fire prevention specialist, U.S. Department of Agriculture Forest Service, San Bernardino National Forest; Jim Miller, locomotive inspector, Wisconsin Department of Natural Resources; and Don Westover, fire supervisor, State of Nebraska. They met in Hammond, IN, in late 1984 to begin the work of putting the program together. Billie Stillson of the U.S. Department of the Interior Bureau of Land Management, Boise Interagency Fire Center, served as training development coordinator and facilitator. Stephen Creech, Indiana Department of Forestry, was the host and support coordinator.

Using an earlier work of the FPWT that identified the tasks involved in a railroad fire prevention effort, the team identified the subjects needing to be covered, developed the format for the presentations, assigned specific course development topics, and began the job of putting the course together. Background materials and resources were drawn from the fire community in an effort to keep "wheel reinvention" to a minimum. There was not a lot out there, but what was available was of considerable help.

Course Testing

In 1985, the North East Area Training Officer (NEATO) was assigned the responsibility of working with the team to test the package, complete any development work that was needed, provide the support necessary to finish the drafting, and begin the review process.

Arrangements were made to test the package at the Middle Atlantic Compact's (MAC) September training meeting at Emmitsburg, MD. Participants in the MAC's September training meeting suggested changes to improve the training program, and on the basis of their comments, extensive revisions were made to the course during the winter of 1985–86.

In June 1986, the second test was conducted at Redding, CA, when the course was presented to representatives of the California Department of Forestry, the State of Oregon Department of Forestry, USDA Forest Service and the USDI Bureau of Land Management. The course was slightly modified as a result of the Redding presentation. The final draft of the course was then submitted to the FPWT and NWCG for review

and eventual inclusion, it is hoped, in the national system as P-211, Railroad Fire Prevention.

Topics and Materials

The course materials currently under review consist of an instructor's guide, student's guide, and 490 35-millimeter slides. The course includes units on the following topics:

- Railroad operations.
- Railroad hazards.
- Railroad risks.
- Hazard reduction.
- Risk modification.
- Safety practices.
- Investigation.
- Railroad fire prevention plan.

The course is organized so that each unit can be taught separately, if necessary, or as a part of a longer course. It is designed for use by prevention personnel of any wildland firefighting agency, including volunteer fire departments.

The instructor's guide provides instructions for setting up a field trip to a railroad facility for inspection of locomotives. At this time, an illustrated glossary is included only in the instructor's guide, but a similar glossary is planned for the student's guide. The student's guide is a looseleaf publication and should serve as a useful reference after the course is completed. Some handouts have been prepared that the student will be able to adapt for use at the home station in carrying out a local railroad fire prevention program. Other handouts will help the user in field identification of railroad problems that could cause fires and in finding solutions to those problems. A list of references is also available. Without the field trip, the course is approximately 12 hours long.

While the course is being reviewed and edited, copies of the instructor's guide and student's guide can be obtained from North East Area Training Center, c/o Wisconsin Department of Natural Resources (WIDNR) Equipment and Training Center, 518 West Somo Avenue, Tomahawk, WI 54487. Since so many slides are used, there is a charge for a set of them. Price information and copying services are available by contacting NEATO Bill Martini at (715) 453-2188 or WIDNR Training Officer John Grosman at the same number. ■

Alkaline "D" Battery Safety Alert

Two incidents involving alkaline "D" 1.5-volt batteries occurred during the 1987 fire season, exposing a potentially dangerous safety hazard:

- An alkaline "D" battery in a standard four-battery headlamp ruptured and caused an explosion. Initial investigation indicated the probable cause of the rupture was the removal of the exterior plastic coating at the bottom and top necks of the two top batteries. As a result, the two bottom batteries shorted out, overheated, and then caused an explosion.
- Electrolytes leaked in the battery pack of a firefighter's headlamp, burning its wearer. Thinking the leak was from a canteen, the firefighter ignored it until he had received a first-degree burn about the size of a silver dollar.

We discussed these incidents with the staff at the Missoula Technology and Development Center (MTDC). The electronics staff at MTDC believes these incidents were caused for the following reasons:

- The batteries were not correctly installed in series (positive to negative) in the battery pack. Batteries must be installed in a series with positive to negative for all four batteries. If one of the four batteries is inserted incorrectly, it will be charged in reverse by the other three, causing it to leak or become hot enough to rupture.
- Alkaline batteries were used instead of carbon-zinc batteries. Alkaline batteries should not be used in a headlamp battery pack. The appropriate battery is a carbon zinc, size D, industrial battery available from the General Services Administration (GSA). The GSA stock number for this battery is: 6135–00–835–7211. The Boise Interagency Fire Center (BIFC) Warehouse National Fire Equipment System number is 0029.

It is also important to inspect batteries carefully for any damage. If damaged, they should be discarded. MTDC personnel stated that taking the above precautions should prevent further safety hazards. ■

Cannibalization of Federal Excess Property on Loan to State Foresters

From time to time, the State Foresters find it necessary to cannibalize Forest Service property on loan to them, both to keep similar equipment operable and to modify military equipment for fire protection. Most of the property in question is used military equipment loaned to the State Foresters by the USDA Forest Service through the Federal Excess Personal Property (FEPP) program.

Cannibalization is defined as the practice of disassembling unserviceable equipment for the purpose of using serviceable parts on other similar units. The removal of any parts other than minor parts is cannibalization.

Cannibalization should be limited to property that is uneconomical to repair and has no value to other users in the program. An alternative to the cannibalization of the limited number of military vehicles available through FEPP is to purchase repair parts from military supply depots through the MILSTRIP system. Contact your Forest Service Cooperative Fire staff member for details.

If cannibalization of loaned Federal property is necessary, an advance request and approval from the Forest Service on Form AD–112, "Report of Unserviceable, Lost, or Damaged Property," is required. Cannibalization itself is a form of use and is not disposal of the property. Property should not be removed from property records until it has been disposed of completely. After all usable parts have been removed, Block 5 of the AD–112 should be signed, dated, and returned to the Forest Service. To remove the equipment from the property records, the proper disposal document (SF–120 or SF–126) needs to be submitted. Cannibalization and disposal documents, like acquisition documents, should be signed by the State Forester.

Some cannibalization will result in one or more pieces of nonaccountable or accountable property. This will require an adjustment to the property records of the State Foresters and the Forest Service. This is accomplished through agreement between both parties to adjust acquisition costs and determine the nomenclature for new property items.

Again, advance approval is required to insure that operable equipment or equipment needed by another unit or agency is not indiscriminately disassembled or destroyed. Cannibalization should be completed within a reasonable timeframe, not to exceed 18 months after the processing of the AD–112. A disposal action will be required for the remaining frame or carcass and an adjustment to the property record. With the approval of the Forest Service, some cannibalizations can be authorized on the SF–122 at the time of acquisition. Accountable property acquired in this manner should be listed on the property records until disposal.

Cannibalization pitfalls, such as the following, should be avoided:

- Unauthorized cannibalizations.
- Cannibalization of operable equipment.
- Requests to cannibalize equipment that are actually lost or missing (to remove from inventory record).
- Lack of record adjustment when FEPP is authorized for cannibalization.
- Cannibalizing major equipment for small minor components.
- Mass cannibalizations that create unmanageable boneyards.
- Failure to report cannibalized carcass for disposal in time allotted. Some think 2½-ton military frames are junk. As long as they are not bent, folded, or mutilated, they are valuable as undercarriage for monster cars, support beams, foundations, and just plain scrap metal.

These are actions that cause trouble with your State Forester, the USDA Forest Service, USDA Office of the Inspector General, General Accounting Office, the State Agency for Surplus Property, and other State forestry agencies. Some of these actions could endanger participation in the FEPP Program. ■

Francis R. Russ, *property management specialist, USDA Forest Service, Fire and Aviation Management, Washington, DC*

The Georgia Rural Fire Defense Program

Don C. Freyer

Rural fire defense coordinator, Georgia Forestry Commission, Macon, GA

In the late 1960's, the Georgia Forestry Commission recognized the necessity to supplement its fire suppression services. Rangers' pickups with 80-gallon fiberglass tanks, Panama pumps, and varying lengths of ¾-inch hose would not always provide adequate suppression when water use was necessary. Forestry units were continually called to structural and vehicle fires because there were no other fire suppression forces available outside of city fire department boundaries. When called to this type of fire, the forest fire suppression units were usually unable to take adequate suppression action.

Program Startup

The Forestry Commission initiated its Rural Fire Defense (RFD) program in June 1968. The Georgia Natural Disaster Operations Plan designated the Forestry Commission as the primary agency responsible for the function of fire control in rural areas. The RFD program was made possible under Section 2 of the Clarke-McNary Act of 1924, which authorized the Secretary of Agriculture to cooperate with State forestry agencies in wildland fire protection, and the Federal Property and Administrative Services Act of 1949 authorizing the loan of Federal Excess Personal Property (FEPP) to a State agency such as the Georgia Forestry Commission through the U.S. Department of Agriculture Forest Service's Cooperative Fire Control program.

The RFD program has enabled local government entities in almost every Georgia county to provide fire protection and its many benefits to their local residents and to visitors. The RFD program goals are as follows:

- Establish voluntary fire protection programs to existing unprotected rural communities by establishing an initial fire protection program.
- Strengthen existing small town and city programs.
- Prepare and update countywide master fire plans.
- Provide the Forestry Commission with a back-up force of men and equipment for emergency forest fire use.

Equipment

The Forestry Commission will loan and lease equipment for firefighting purposes under a cooperative lease agreement with a government entity. A "government entity" is considered to be the Board of County Commissioners or the mayor of a town with a registered active State charter.

The Commission leases equipment of various types to cooperators through the FEPP program. Cooperators can lease equipment that they agree to develop into serviceable firefighting units or equipment already modified by the Commission for fire use. Most equipment leased are units such as quick response vehicles, fire knockers, mobile water supply units, and front-mount pump tankers which have been converted by Commission personnel in Commission facilities. These units are leased at material cost and have proved to be highly efficient and effective pieces of equipment provided at a cost which communities can afford. In many instances, the Commission has furnished pumps, hose, reels, and miscellaneous items to cooperators as it became available through the FEPP program for vehicles or trucks purchased by local departments.

For many years, rural volunteer firefighting groups usually responded to only natural cover fires (forest, grass, and brush) since their equipment, training, and communications did not lend itself to the suppression of structural or vehicle fires. To increase the firefighting capability, improve the effectiveness of these rural fire departments, and provide for safer operation of equipment, the Forestry Commission developed the 950-gallon "fire knocker." This unit enabled volunteer personnel to have the capability of continuing to assist the Forestry Commission in natural cover fire suppression as well as being able to suppress structural fires effectively and adequately.

The fire knocker continues to be updated to provide volunteers with a unit that best suits needs across the state. A 1,250-gallon and a 1,560-gallon water supply unit are also available on a lease basis. The front-mount pump tanker is a Class "A" pump with the same 1,250- or 1,560-gallon tank and quick dump. Units are suitable for mounting on a truck chassis furnished by the leasing government entity. The unit is paid for by the lessee on a lump-sum basis prior to delivery and is "on lease" for a 50-year period. Recently, the Forestry Commission added to its services the loan of pumps and other equipment for the delivery of water to tankers and the transport of this water to the fire scene.

FEPP of all types is distributed, as available, on the basis of a request received from a qualifying government entity on a Georgia fire control form (FC–61). However, the number of major pieces of equipment being issued is not increasing at the pace it has in the past because of the decrease in availability of FEPP and the necessity for replacing unserviceable vehicles that have been in the program for many years.

Training and Planning Service

The RFD program is geared to provide timely technical assistance to RFD cooperators and their personnel. Advice and assistance are provided RFD departments throughout the State on a continual basis. Requests for assistance are received from the volunteer departments through the local Forestry Commission rangers. The Forestry Commission does not provide basic firefighting training since this training is supplied by the Georgia Fire Academy.

The Forestry Commission also offers countywide master fire planning service to county government entities that request this service.

The first step to successful fire protection for any community is a sincere desire of the governing officials and the citizens to plan, organize, and implement the program on the local level for the protection of life and property. Once a decision is made on the local level to develop a fire protection program, an official request from the governing officials of the county should be forwarded to the Forestry Commission for assistance in preparing a master fire plan.

In preparing a master fire plan, Commission personnel consider what is practical and economically feasible for a community. All counties cannot finance a full-time paid fire department or the most expensive equipment. A practical plan that can be implemented is much better than a costly plan that is impossible to finance and operate.

The primary goal of master fire plans is the protection of life and property from fire. The secondary purpose is to improve the fire defense in the area of protection. In preparing the plan, every consideration is also given to providing a service which will help a community meet the requirements of the Insurance Services Office of the State of Georgia for an insurance classification rating.

Fire protection has been largely a local responsibility, and for good reason it is destined to remain so. Each community has a set of conditions unique to itself, and a system of fire protection that works well for one community cannot be assumed to work equally well for other communities. To be adequate, the fire protection system must respond to local conditions, especially to changing conditions. Planning is the key: Without local-level planning, the system of fire protection is apt to be ill-suited to local needs and lag behind as the community changes.

The planning process includes a complete assessment of existing protection, an analysis of the fire problem, and a recommended fire organization to meet the community's needs efficiently. After adoption of the plan by county government, the Forestry Commission stands ready to provide technical assistance in implementing the plan. ■

Production Guidelines for Initial Attack Hotspotting[1]

University of Alberta

Dennis Quintilio, Peter J. Murphy, and Paul M. Woodard

Senior fire control instructor, Alberta Forest Technology School, Hinton, AB, and, respectively, associate dean of forestry and associate professor, University of Alberta, Edmonton, AB

Introduction

Much literature has been published since the 1930's concerning the rate of production of hand-constructed fireline (McReynolds 1936, Anon. 1940, Hulett 1940, Hanson 1941, Hanson and Abell 1941, Lindquist 1970, Ramberg 1974, Bratten 1978, Murphy and Quintilio 1978, Haven *et al.* 1982, Schmidt and Rinehart 1982). In the boreal forest of northern Alberta, continuous hand-constructed fireline is rarely used during initial attack. Initial attack actions usually involve hotspotting by crews of three to six members accompanied by a helicopter equipped with a bucket, and airtanker delivery of water or chemical retardants. The objective of this action is to contain the fire quickly and efficiently by stopping any flaming combustion, thus halting fire spread. Cold trailing and infrared scanning are subsequently used during mop-up to ensure that fires are completely extinguished.

This paper presents measurements of initial attack hotspotting production rates on a series of test burns performed in the boreal forest of northern Alberta. These rates are then compared with continuous line production rates in similar fuel types.

Study Area

Prescribed burns were conducted by the Alberta Forest Service (AFS) approximately 70 kilometers (43 mi) east of Wabasca, AB (lat. 55°58′ N, long. 113°50′ E). Much of the vegetation in this area consists of muskeg and is of low commercial value. However, there are raised islands of typical boreal forest stands composed of jack pine *(Pinus banksiana* Lamb.), black spruce (*Picea mariana* (Mill.) B.S.P.), and white spruce *(P. glauca* (Moench) Voss). A detailed description of the environmental and vegetation characteristies of the area can be found in Strong and Leggat (1981).

Methods

Potential sites for the test fires were selected in representative upland forest types within the study area. All sites had a homogeneous cover of representative boreal fuels and were bordered by features such as wet areas that would aid in backup fire control. The overstory vegetation on the selected sites was dominated by either jack pine or black spruce. Jack pine was the most common forest type in the area. Black spruce is considered the most flammable type due to the vertical and horizontal continuity of fuels in this type. Because of their high flammability, black spruce stands are expected to present the greatest challenge to initial attack efforts.

A portable recording weather station was established in an open area approximately 10 kilometers (6 mi), east of the proposed burn areas. Daily noon readings of temperature, relative humidity, wind speed, and 24-hour precipitation from this station were used to calculate values for Canadian Forest Fire Weather Index System (CFFWIS) variables. Hourly wind speeds from the weather station were used to calculate adjusted values for the Initial Spread Index at the time of ignition. Supplementary weather observations were made on site as necessary.

Crew standards were established as follows: trained crews fighting the fire in an initial attack mode; full crew readiness; and fresh in attack capability, employing a hotspotting technique. Crew size ranged from seven to nine members with six to eight crew members actually attacking the fire. Each crew was accompanied by a helicopter with bucket to assist with control, if necessary, and to later assist in mop-up operations.

A grid of reference stakes was placed on each burning site to aid in measuring rates of fire spread. Progress of the burns was monitored by two video cameras: one hand-held by an observer along the fire edge and the other by an aerial observer in a helicopter. In addition, verbal commentary notes were dictated to provide a running assessment of fire characteristics including flame height, length, and depth; candling, crowning, and spotting behavior; and rate of spread and observations on the techniques and effectiveness of the attack.

Fires were ignited with fusees and allowed to grow to a size of 0.10 to 0.25 hectares (0.25 to 0.60 acres). At that point the crew was called in to attack. Time to control was defined as the length of time from crew arrival at the fire until the last perimeter flame was out. Mop-up time was considered a separate

[1]The Canadian Forestry Service provided financial support for this study through the program for research by Universities in Forestry (PRUF). The Alberta Forest Service provided assistance in the form of manpower, equipment, and location for testing.

function and is not included in our analysis.

Eight burns (four in jack pine and four in black spruce) were conducted between August 1 and 5, 1986. One additional burn was conducted in a jack pine stand on July 24, 1987.

Calculations of rates of held-line productivity for the test fires were based on the final perimeter of the fire, number of crew members actually attacking the fire, and time to control. Construction rates for continuous handline were taken from initial attack simulations described by Murphy *et al.* (1987). In order to determine whether the fuel types for the prescribed burns were comparable to those for the initial attack simulations, expected fireline production rates, based on fuel resistance, were calculated as described by Murphy and Quintilio (1978). The expected rates in the fuel types where the prescribed burns were conducted were greater than the expected rates for the simulations. In order to account for this difference in fuel types, the measured rates for the simulations were multiplied by the ratio of the mean expected rate for the prescribed burns to the mean expected rate for the simulations. This comparison and adjustment was done independently for jack pine fuel types and black spruce fuel types.

Full documentation of fuel types, on-site weather, and fireline production rates is difficult during actual initial attack operations. The use of prescribed fires is a new approach for assessing the productivity of initial attack crews. This approach proved to be extremely valuable during this study. The researchers gained a great deal of insight from watching crews at work on actual fires and learned how crew leaders evaluate fires and allocate personnel and equipment. Video tapes of the prescribed fires provided valuable training materials for other crews as well as those involved in the study. Debriefing of fire crews was of great training value, and the efficiency and productivity of the crews appeared to increase with subsequent fires. This apparent learning factor may have masked some of the effects of fuel types and weather-related variables on production rates. This may have contributed to the low correlations found between weather-related variables, fire behavior variables, and fireline production rates.

Correlation coefficients were calculated to relate hotspotting fireline production rates to on-site weather, CFFWIS variables, and observed fire behavior.

Results and Discussion

The nine sites selected for test fires were characterized by an open overstory canopy (≤50% crown closure) and relatively low tree heights (≤18 m or ≤ 59 ft) (table 1). All nine fires developed into running surface fires (table 1). Candling was observed on all four fires in black spruce stands and on two of the five fires in jack pine stands (table 1). Crowning occurred during two of the fires conducted in black spruce stands (table 1). Values for average rate of spread, flame length, and flame depth were relatively low for all nine fires (table 1).

The average hotspotting rate of held-line production in jack pine was 282 meters (925 ft) per man-hour compared with 52 meters (171 ft) per

Table 1—*Overstory cover-type characteristics and fire behavior for nine test fires conducted in the boreal forest of northern Alberta*

Overstory cover-type and fire behavior characteristics	Tree species for nine test fires[1]								
	Test 1 (Pj)	Test 2 (Pj)	Test 3 (Pj)	Test 4 (Pj)	Test 5 (Pj)	Test 6 (Sb)	Test 7 (Sb)	Test 8 (Sb)	Test 9 (Sb)
Crown closure (%)	6–30	31–50	31–50	6–30	31–50	6–30	31–50	6–30	6–30
Tree height (m)	13–18	13–18	13–18	13–18	6–12	6–12	6–12	6–12	6–12
Running surface fire[2]	Y	Y	Y	Y	Y	Y	Y	Y	Y
Candling[2]	N	Y	N	N	Y	Y	Y	Y	Y
Crowning[2]	N	N	N	N	N	N	Y	Y	N
Rate of spread (average, m/min)	2.8	1.3	0.6	1.0	1.0	1.5	3.3	2.1	2.2
Flame length (m)	0.33	0.44	0.33	0.33	0.25	0.75	1.00	2.00	1.50
Flame depth (m)	0.67	0.50	1.00	0.18	0.15	0.50	1.00	1.50	1.00

[1]Pj is the abbreviation for jack pine and Sb, for black spruce.
[2]Y identifies observed fire behavior; N identifies unobserved fire behavior.

man-hour for construction of continuous handline (fig. 1). In black spruce, the average hotspotting rate of held-line production was 232 meters (761 ft) per man-hour compared with 30 meters (98 ft) per man-hour for construction of continuous handline (fig. 1). Although statistical tests of significance would be inappropriate due to our small sample size, the magnitude of the differences clearly demonstrates the superiority of hotspotting as an initial attack technique.

Correlations between hotspotting rate of held-line production and onsite weather, CFFWIS, and fire behavior variables are very weak (table 2). Rate of held-line production seems to be most dependent on Fine Fuel Moisture Code, temperature, and flame depth. Because of the small sample size for this study, these correlations should only be used as an indication of which variables should be most closely examined during further research. It is hoped that with data from more fires, multiple regression analysis may provide more meaningful results. It should also be noted that all of the fires examined in this study burned at low intensities as indicated by flame lengths (table 1). The addition of data from fires burning at higher intensities may reveal different relationships than those found here. ■

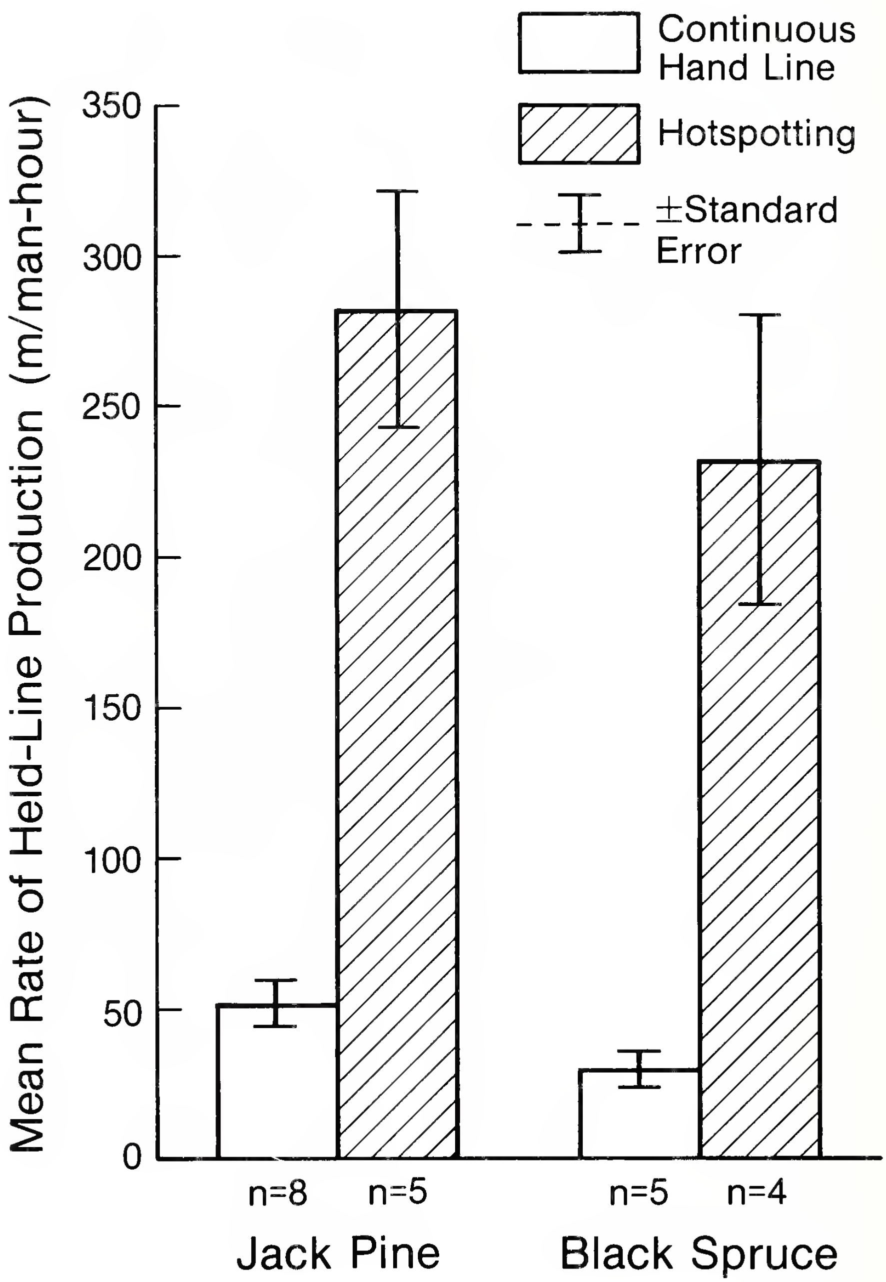

Figure 1—*Comparison of hotspotting rates of held-line production to rates of continuous handline production in jack pine and black spruce forest types in northern Alberta.*

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Table 2—*Correlation coefficients between hotspotting rate of held-line production and on-site weather, Canadian Forest Fire Weather Index System (CFFWIS), and fire behavior variables for test fires in northern Alberta*

Variable	n	Coefficient of correlation with hotspotting rate	P
On-site weather			
Temperature	9	0.51	0.079
Relative humidity	9	−0.36	0.169
Wind speed	9	−0.14	0.362
CFFWIS			
Fine Fuel Moisture Code	9	0.56	0.059
Duff Moisture Code	9	0.09	0.406
Drought Code	9	−0.16	0.342
Initial Spread Index	9	−0.001	0.499
Adjusted Initial Spread Index[1]	9	0.20	0.303
Buildup Index	9	0.11	0.393
Fire Weather Index	9	0.06	0.441
Fire behavior			
Average rate of spread	9	−0.37	0.164
Maximum rate of spread	9	0.45	0.110
Flame length	9	0.14	0.355
Flame depth	9	0.48	0.097

[1]Initial spread index calculated with noon Fine Fuel Moisture Code and wind speed at time of ignition.

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Wildland Interagency Engine: A Pilot Program

Troy Corn

Assistant fire management officer, USDA Forest Service, Wenatchee National Forest, Entiat Ranger District, Entiat, WA

Tight suppression budgets and fire hazards associated with scores of new homes in wildland areas of North Central Washington State have led to interagency sharing of personnel and fire equipment. This trend of migration by city dwellers into urban/wildland interface areas is expected to continue. Protection of life and property from wildfires in these rural areas has become a complex issue for local firefighting agencies.

In 1987, because of a growing need for multiagency fire suppression in urban/wildland interface areas, Chelan County Fire District No. 1, Wenatchee National Forest, and the Washington State Department of Natural Resources' Southeast Region initiated the Wildland Interagency Engine pilot program.

The Wildland Interagency Engine is unique in its design and mission in that 7-day staffing was provided by three separate agencies. Officials from the cooperating agencies believed that the program would achieve three important administrative goals: Provide a fire suppression resource with a quick response time in volatile urban interface areas, provide an important cost savings to all agencies, and provide a highly visible example of cooperation among fire protection agencies in support of a national emphasis on interagency cooperation.

During an 8-month planning period the cooperating agencies developed an operational agreement which satisfied the legal needs of each agency. Using this operational agreement as a cornerstone, the program functioned smoothly and contributed significantly to the wildland fire suppression effort in Chelan County. The Wildland Interagency Engine was actively involved in 22 wildland fires and provided protection of wildlands and logistical support during structure fire suppression in the interface areas. During the 1987 fire season in northern California and southern Oregon, the Washington State Department of Natural Resources and Wenatchee National Forest in Chelan County often found themselves depleted of adequately trained firefighters. Also, at this same time, Chelan County was experiencing extreme fire danger ratings brought on by one of the worst drought periods on record. During this dry spell, the Wildland Interagency Engine was instrumental in providing fire protection to all cooperating agencies throughout Chelan County.

All officials involved with the Wildland Interagency Engine agree that the pilot program was a cost beneficial investment. Each participating agency contributed one-third of the program cost. This joint funding approach allowed the three-member agencies to receive the benefits of a complete engine crew. Because of reduced budgets in 1987, no single participating agency would have been able to adequately fund the engine.

Each agency in the Wildland Interagency Engine provided support and participated in the training program. Support was provided in the following manner:

- Each agency—One primary and one backup crewperson and equipment for that crewperson; regular and overtime cost and benefits for own employee.
- Chelan County Fire District No. 1—A centrally located station and office space; a King radio; reserve engine equipment; vehicle maintenance; hose and equipment maintenance.
- The Wenatchee National Forest—A primary engine (16,500 gross vehicle weight, 700 gallon), engine equipment, and a Phoenix radio.
- The Washington State Department of Natural Resources—A backup vehicle, portable radio batteries, and a foam agent and foam equipment.

The topics covered in the training program and the hours spent training in each area are as follows:

Topic	*Hours*
Physical training (on-going)	55
Initial attack	16
Mop-up, dry and wet	8
Radio use and care	2
Class 1 engine operation	4
Portable pumps	3
Map and compass	2
First aid	5
Handtool use	5
Line construction	10
Fire behavior	4
Water application and hoselays	10
Interagency coordination on fires	6
Type 5 engine operation (primary vehicle)	8
Ladder truck operation	4
Self-contained breathing apparatus	4
Fire shelters	4
Total	150

Based on an end of fire season review by lead officials of all participating agencies, all crew performance ratings were above average,

contributions of the Wildland Interagency Engine were significant in the areas of wildfire suppression, and mutual understanding and cooperation between involved agencies was much improved. In addition, all participating agencies thought good value was received for the funding they contributed to the program and are looking forward to improving operations during the 1988 fire season. ■

A Wildland Interagency Engine crew with engine.

Standards for Survival

More than 140 firefighters were entrapped during the 1987 fire season. Unfortunately, one firefighter lost his life. During the past 3 years, several hundred firefighters have been forced to deploy their shelters in a "last resort" situation. Investigation reports revealed obvious and continuing violations of "Watch Out!" situations and Standard Fire Orders, prompting the need to review and improve training.

A new interactive firefighter safety course titled "Standards for Survival" has been developed. The principal focus of the course is on the proper recognition of the "Watch Out!" situations followed by the initiation of the appropriate actions as defined in the Standard Fire Orders.

In addition, some adjustments were made in the "Watch Out!" situations and Standard Fire Orders. Five items have been added to the "Watch Out!" situations to reflect critical hazardous conditions that are not readily recognized. These include:

- Fire not scouted and sized up (1).
- Safety zones and escape routes not identified (3).
- Uninformed on strategy and tactics (5).
- Constructing lines without a safe anchor (8).
- Attempting a frontal assault on the fire (10). Also, the list has been arranged in the sequence in which the hazardous situations are most likely to occur.

"Watch Out!" Situations

1. Fire not scouted and sized up.
2. In country not seen in daylight.
3. Safety zones and escape routes not identified.
4. Unfamiliar with weather and local factors influencing fire behavior.
5. Uninformed on strategy, tactics, and hazards.
6. Instructions and assignments not clear.
7. No communication link with crew members/supervisors.
8. Constructing lines without safe anchor point.
9. Building fireline downhill with fire below.
10. Attempting frontal assault on fire.
11. Unburned fuel between you and the fire.
12. Cannot see main fire—not in contact with anyone who can.
13. On a hillside where rolling material can ignite fuel below.
14. Weather is getting hotter and drier.
15. Wind increases and/or changes direction.
16. Getting frequent spot fires across line.
17. Terrain and fuels make escape to safety zones difficult.
18. Taking a nap near the fireline.

The Standard Fire Orders were recast in a new format using the acrostic technique to trigger recall. The acrostic is an arrangement of sentences, each keyed to and beginning with the letters contained in FIRE ORDERS. This technique is highly effective in promoting retention of the information.

Sense of the Standard Fire Orders has not been changed, but the order has been changed to conform to the acrostic structure. For example, the familiar Fire Order No. 10, "Fight fire aggressively, but provide for safety first," now becomes the first fire order in the format. This order is properly the first since it provides the overall basic safety rule. The order not only applies to potential entrapment situations, but to safe driving, use of tools and equipment, aviation, and other activities as well.

Standard Fire Orders

F —Fight fire aggressively but provide for safety first.
I —Initiate all action based on current and expected fire behavior.
R —Recognize current weather conditions and obtain forecasts.
E —Ensure instructions are given and understood.

O —Obtain current information on fire status.
R —Remain in communication with crew members, your supervisor, and adjoining forces.
D —Determine safety zones and escape routes.
E —Establish lookouts in potentially hazardous situations.
R —Retain control at all times.
S —Stay alert, keep calm, think clearly, act decisively.

The "Standards for Survival" training course is a 1-hour video tape supplemented with student workbook and exercises. Eight "scenarios"—reenactments of dangerous fireline situations that led to fatalities—are used to pinpoint critical fireline events. Students are asked to identify hazardous situations noted in the scenarios, key them to the 18 "Watch Out!" situations, and then state the appropriate Fire Orders that must be observed.

Course materials are available through the Boise Interagency Wildfire Center. ■

Jerry Monesmith, *safety and training group leader, USDA Forest Service, Fire and Aviation Management, Washington, DC*

International Wildfire Conference—1989

During the past decade, wildfires have caused major losses of life, property, and natural resources in Africa, North and South America, Asia, the Mediterranean, Australia, and parts of Europe. Expanding populations in high-fire risk areas and the accelerating demand for natural resources to supply basic human needs add to the critical nature of this fire problem.

Recognizing that this global problem is at a point where international attention is needed, the Canadian Forestry Service; the National Fire Protection Association; the National Association of State Foresters, U.S. Department of the Interior, Bureau of Land Management; The Secretary of Agriculture and Hydrolic Resources; Normatividad Forestal (Mexican Forest Service); and the U.S. Department of Agriculture, Forest Service are organizing and sponsoring an international conference titled "Meeting Global Wildland Fire Challenges." This conference will focus on worldwide wildfire problems and steps that can be taken by the international community to reverse the upward trend of wildfire losses. The conference will be held in Boston, MA, July 23 to 26, 1989.

Through this conference, we will stimulate the development of international cooperation and enhance disaster assistance for mutual benefit. Additionally, we will bring together leaders of public and private organizations from around the world to discuss issues, programs and strategies to reduce serious wildfire losses and to promote international cooperation.

The goals of the international conference are:

- Identify and assess worldwide wildfire management problems, including social and economic impact.
- Heighten public and government awareness of the serious global wildfire problem.
- Increase international cooperation and strengthen communications between individuals and organizations responsible for wildfire management.

Conference participants—countries, states and provinces of countries, and organizations concerned with firefighting—will provide educational displays describing fire situations and programs in their areas and on issues of importance. These displays, covering a wide spectrum of fire management programs, are a key part of the conference, enhancing its educational value in a significant way. The educational display coordinator for the conference is: Roger Erb, U.S. Department of the Interior, Bureau of Land Management, Fire and Aviation Management, 18th and C Streets NW, Washington, DC 20240, (202) 653-8800. ■

Fourth International Firefighting Course

Paul J. Weeden

Defense and emergency operations specialist, USDA Forest Service, Fire and Aviation Management, Washington, DC

The Fourth International Wildfire Suppression Course was hosted by the Mexican Government in Mexico City from January 25 to February 12. It was jointly sponsored by the Office of Foreign Disaster Assistance, the Normatividad Forestal (Mexican Forest Service), and the USDA Forest Service.

The course was a resounding success and continues to be a positive experience for all those who participated. The course has also broadened horizons and enhanced relations within and between countries in regard to wildfire suppression and conservation of natural resources. It has provided an avenue to explore new technologies or firm up those that already existed. Instructors and students left Mexico City exhausted, but with a sense of accomplishment.

During 2 weeks of intensive classroom study and 1 week of field exercises, 50 participants were taught the following courses: Fire Behavior, Fire Prevention and Detection, Instructor Training, Fuels Management, Safety and Certification, Emergency Management System, Fire Analysis and Evaluation, and Protection Plans.

Besides providing training in these subject areas, a second objective of the course was to prepare each participant to be an instructor. Participants could then return to their respective countries and instruct others in wildfire suppression techniques.

The National Advanced Resource Technology Center (NARTC) had taken the lead role for the Forest Service in the development of the previous three international fire suppression courses and will continue to coordinate future courses for structure and materials. The fourth course was held in Mexico City to make it more readily available to participants from Central America and Mexico.

Students and instructors came from Mexico, Central America, South America, North America, and Europe. Their number and distribution among countries represented were as follows:

Students	*Instructors*
1 Argentina	1 Chile
3 Ecuador	1 Costa Rica
3 Honduras	4 Spain
3 Nicaragua	5 United States
8 Guatemala	12 Mexico
9 Costa Rica	
24 Mexico	

Instructors from the United States were: Gary Benavidez (Magdelena District, Cibola National Forest, R-3); Pat Velasco (Payson District, Tonto National Forest, R-3); Roberto Rodriguez (Illinois Valley District, Siskiyou National Forest, R-6); Jay Perkins (Ukonom District, Klamath National Forest, R-5); and Paul Weeden (Fire and Aviation Management, Washington, DC).

A significant accomplishment of the course was to include women for the first time: one as a steering committee member and instructor and three students—one from Guatemala and two from Costa Rica.

During an awards ceremony at the end of the course, Bonnee Turner, training specialist with NARTC, presented Jay Perkins with a plaque recognizing his substantial effort in coordinating the fourth course. On behalf of USDA Forest Service Chief, Dale F. Robertson, Paul Weeden presented Jesus Cardena, Chief of the Mexican Forest Service, a signed and numbered limited-edition print titled, "Forest Fires Campaign—1987," to recognize the significant contribution of the Normatividad Forestal to the success of the course.

Another course highlight was the signing of the "Adhesion de la Gran Hermandad de Prometeo" or the "Binding of the Association of Prometheus." This tradition started in the first course with the signing of the "Declaration of Promise" and has been carried over into subsequent courses. The power of the Association is difficult to explain, but it has given rise to international agreements and cooperation through technology and literature exchanges. The Association has had a very positive impact on the wildfire suppression course and relations between participating countries, despite the fact that participants come from countries with diverse ideologies on fire management.

A translation of the "Adhesion de la Gran Hermandad de Prometeo" follows:

The Binding to the Association of Prometheus

Having created and developed in previous International Wildfire Suppression Courses the Association of Prometheus, whose end is to unite those that have participated in these courses,

We

the participants in the Fourth International Wildfire Suppression Course,

Closing ceremony of Fourth International Forest Fire Course. Seated at the table, from left to right: Patricia Santos, training officer, U.S. Agency for International Development, representing the U.S. Ambassador; Jay Perkins, steering committee chairman and course coordinator, USDA Forest Service; Juan Rodriquez Jacquez, Director of Coordinating Commission for Rural Development of Mexico City; Paul Weeden, steering committee member and instructor, Fire and Aviation Management, USDA Forest Service; Manuel Villa Issa, Subsecretary of Forestry and Agriculture; Jesus Cardena Rodriquez, Director, Normatividad Forestal (Mexican Forest Service); Bonnee Turner, course coordinator and steering committee member, NARTC; and Jamie Lopez. A translation of the caption on the table and the wall above the table is as follows: "Fourth International Forest Fire Course."

organized by the Secretary of Agriculture and Water Resources, the United States Forest Service, the Agency for International Development and the National Advanced Resource Technology Center, held in Mexico City, from January 25 to February 12, 1988, in the Natural Resource Conservation and Training Center for Ecoguardas of the Coordinating Commission for Rural Development of Mexico City,

Declare

our plain intention to unite as members with all of those before us that have subscribed to the union and fraternity of this pact. For this, it will be

Our Pledge

to pay tribute to the forest resources in particular and the natural resources in general, the best of our strength, dedication, and work in favor of their conservation and protection, for the benefit of our communities as well as for the benefit of future generations. Also, we will encourage technical communication and an exchange of experiences with the purpose of mutually helping each other, as individuals as well as countries.

In Binding With

the members of this international association, we place our names and countries with the intent to incorporate ourselves to

The Association of Prometheus

to improve the knowledge and techniques in wildfire suppression to protect life, property and natural resources. ■

Fire Management in Israel

Kimberly Brandel, Mike Rogers, and Gordon Reinhart

Respectively, USDA Forest Service, fire planning assistant, Washington, DC; fire management officer, Umatilla National Forest, Pendleton, OR; and forest supervisor, Cleveland National Forest, San Diego, CA

Israeli firefighters will remember 1987 as the year that fires raged throughout Israel, damaging many forests. Israel experienced twice as many wildfires in 1987 as in 1986. In the B'nai B'rith Martyr's Forest, 50 acres (20 ha) of the Children's Forest were destroyed. An additional 875 acres (354 ha) of natural woodland were destroyed in the area of the Martyr's Forest. On July 29, four fires burned a total of 1,150 acres (465 ha) in the forests surrounding Jerusalem. As a result of the fires, electricity was cut off from west Jerusalem neighborhoods for several hours. Damage estimates exceeded $2 million.

In the fall of 1987, the Jewish National Fund (JNF), the agency responsible for afforestation and land reclamation in Israel, requested that a team of fire management specialists from the U.S. Department of Agriculture (USDA) Forest Service visit Israel to assess their fire management needs. The team, consisting of team leader Mike Rogers, Gordon Reinhart, and Kimberly Brandel, spent 10 days in early December 1987 traveling throughout Israel meeting with resource professionals and being briefed on the fire management situation.

In this article, we will attempt to explain the current fire management situation in Israel. An understanding of this topic requires some background information on the development of forests in Israel and on attitudes towards those forests.

Establishment of Forests in Israel

Palestine is the land located between the Mediterranean Sea and the Jordan River that was occupied by the Hebrews in the second millennium B.C.E. The Hebrews were driven out of the area repeatedly by a succession of invaders and conquerors and eventually dispersed throughout the world.

In the late 1800's, the Zionist movement, whose aim was the reestablishment of a Jewish homeland and state, gained momentum in Europe. The Jewish National Fund (JNF), the operative arm of the Zionist movement, was established in 1901 with the express aim of purchasing land in Palestine for the eventual reestablishment of the Jewish homeland.

The land that the JNF purchased in Palestine had changed considerably from the land described in the Bible. Historically, much of Palestine was covered with oak scrub and pine forests. The many conquests and occupations of Palestine throughout history resulted in the loss of these forests and subsequent overgrazing. The practice of overgrazing continued well into the 20th century.

The JNF realized that they would have to undertake extensive reclamation and environmental improvement projects if the land was to become productive. The JNF started planting trees in the early 1900's. Most of the trees, however, were planted after the State of Israel was established in 1948. Today, due to a highly successful and continuing afforestation effort, forested areas cover about 5 percent of the land base. Natural Mediterranean woodlands make up 100,000 (36,900 ha) of the 270,000 (109,268 ha) forested acres. JNF-sponsored tree nurseries prepare 5 million saplings for planting in new forests each year.

Forestry is an emotional issue in Israel; nearly all of the forests were planted for either social or security purposes. The Jews who came to Palestine after World War II and fought to establish the State of Israel wanted forests similar to the forests of Europe that they had left behind. They realized that a forest is a legacy for future generations. Many of the forests, including the Children's Forest, were planted in memory of the Holocaust victims to ensure that the horrors the Jewish people had endured would always be remembered.

The people of Israel also realized that forests are an asset to national security. Forests planted along the borders of Jordan, Syria, and Lebanon hinder military tank movement into Israel.

The Israelis refuse to assign a dollar value to their forests. Emotionally, they feel that their forests are invaluable and must be protected at all costs. Rationally, however, they realize that they do not have an unlimited budget to do so. Thus, when confronted with an escalating fire problem, JNF sought assistance from the USDA Forest Service to

design a cost-effective fire management program.

Israel's Forests Today

Israel's forests are composed primarily of stands of Aleppo pine *(Pinus halepensis)*, the only conifer species indigenous to Israel. During the initial afforestation effort, this species was planted almost exclusively because it is one of the few conifers that is adapted to the harsh environmental conditions of Israel. Today, many of these stands are densely overstocked and in poor health. The initial afforestation effort included plans for thinning. However, thinning frequently was delayed due to the emphasis on tree planting.

Insects contribute to the poor health of many stands. Aleppo pine is extremely susceptible to infestation by the Israel pine Matsucoccus *(Matsucoccus joshephi)*. In recent years, an effort has been made to diversify species composition and extensively plant conifers that are resistant to infestation.

The life expectancy of Aleppo pine is 60 to 80 years. Stands that were planted in the early 1900's are reaching maturity and "breaking down," creating available fuel for fires. Moisture stress, insects, and disease also are contributing to the stands' susceptibility to fire damage.

The Fire Problem

Fire is a relatively new problem to the forests of Israel. Even though the Israelis would like to eliminate all fires, their forests will continue to experience large catastrophic fires. The combination of a hot, dry Mediterranean climate, strong winds, steep inaccessible terrain, highly volatile fuels, and high potential for ignitions results in a scenario that virtually eliminates the possibility of total prevention of forest fires.

Typical conditions in stand of Pinus halepensis.

Approximately 550 forest fires occur each year in Israel—95 percent between May and August. The majority occur in June and July. An additional 300 fires occur each year in nonforested lands. Approximately 2,400 acres (971 ha) burn each year in forested land; another 7,200 acres (2,914 ha) burn each year in nonforested land. Suppression efforts confine most fires to less than 1.2 acres (0.5 ha). Only 1.5 percent of the fires grow larger than 25 acres (10 ha). Multiday fires are the exception rather than the norm.

Seventy-two percent of forest fires are of unknown origin. However, all forest fires are human caused. The most common known cause of fires is arson, followed by negligence, campers, and army maneuvers.

Four main factors are responsible for the recent increase in fires. First, forests and associated roads and recreation areas are being expanded. As a result, the forests are being visited more frequently, increasing the probability of fires.

Second, a land use conflict has arisen based upon the traditional use of the land for grazing. Shepherds set fire to the land both to improve grazing and to reclaim traditional grazing areas.

Third, many forest stands border fertile valleys where grain crops are grown. When the farmers burn their fields, fire often escapes into the surrounding forests.

Fourth, fires due to politically motivated arson are increasing. In the Middle East, planting trees implies ownership of the land. By setting fire to the forests, Israel's political adver-

saries are attempting to destroy this symbol of ownership.

Fire Management

Natural resources are managed by several agencies in Israel. The Forest Department of the Land Development Authority of the JNF is responsible for all forest operations and forest protection. The Nature Reserve Authority is responsible for managing the nature reserves; the National Gardens Authority administers the National Parks.

The Forest Department has acquired responsibility for fire protection of all lands (forested and nonforested) by default rather than by intent. The fire management responsibilities of each land management authority are not outlined in formal agreements.

The Forest Department is divided into four geographical regions; northern, median, central, and southern. Each region is divided into three districts. Approximately 10 to 15 percent of the Forest Department's yearly budget is allocated for fire prevention and suppression.

During the fire season, the Forest Department employs approximately 1,600 people that are available for firefighting. Although most of the fires start in the late afternoon, the employees finish their workday at 4 o'clock in the afternoon. A third of the employees remain on call during the night and are contacted by phone when needed for fire duty. Between 1 and 2 percent of the fires start at night.

Thirty-three lookout towers are distributed throughout the forests. Each lookout is staffed from early May through October and is equipped with a radio system to maintain communications with forest workers. One of the lookout towers serves as a base station for communications with all of the other lookouts; adjacent lookout towers share the same radio frequency. Eighty percent of fires are discovered by lookouts.

Employees work in groups of 10 that are spread out in the forests according to a pre-established work plan. A truck, equipped with a communications radio, is assigned to each group. Each truck carries fire hose, scraping tools, swatters, and backpack pumps. Each group responds to the direction of a specific lookout tower. When a fire is detected, the area lookout contacts the work group and provides them with directions to the fire.

Initial attack response time averages 20 minutes. Experience has shown that if response times are maintained at less than 30 minutes, control usually is not a problem.

The Forest Department has very few fire engines and must rely upon the rural fire brigades for water support. The primary responsibility of the brigades is to fight structural fires in urban and rural communities. Thus, the brigades are not always available when the Forest Department requests them. The engines that are used by the brigades also are not well suited for traveling forest roads. The Forest Department reimburses the brigades for all expenses.

A system establishing command authority for fires has not been developed. As a result, confusion frequently arises concerning who is

Fire engine of the Forest Department of the Land Development Authority of the JNF.

in charge of the fire. Forest Department employees typically turn responsibility for the fire over to the brigade personnel even though the brigades may not be best qualified to fight wildland fires.

An extensive system of fuel breaks divides the forests into areas that are less than 50 acres (20 ha) in size. The fuel breaks are constructed against the prevailing wind patterns and are maintained by mechanical means and by aerial application of chemical sprays. Simazine and atrazine are the chemicals most commonly used. Strategies for controlling the fire rely more on the use of fuel breaks and roads than upon fireline construction.

Israel's forests are densely roaded. Before a forest is planted, access roads are constructed. Currently, road density averages 100 feet for each acre of forest. As a result, access is not a major problem for firefighters.

The Forest Department uses fixed-wing agricultural aircraft for firefighting. However, air support generally is not requested until all other firefighting options have been exhausted. Cropduster planes are used for dropping both water and retardant. Helicopters were tried unsuccessfully for firefighting a few years ago.

In the past, fuels treatment was not considered economical. The Forest Department was not convinced of the value of investing in fuels treatment to decrease resource damage due to wildfire. Thinning slash frequently was left untreated. Attitudes toward the value of fuels treatment, however, are changing. Whole-tree logging is being used to reduce fuel accumulations that result from thinning operations. Grazing has been introduced into planted forests and is once again being used in natural areas.

Prescribed fire is a controversial subject among forestry professionals in Israel. Some professionals feel that, based upon biblical references, fire has a role in Israel's ecosystems. They believe that since people have lived in Israel for thousands of years, human-caused fires are an integral part of the ecosystem. Others maintain that, in the absence of lightning, no proof exists that fire plays a natural role in the development of Israel's forests. The major tree species, Aleppo pine, has thin bark and is very susceptible to fire damage. The Forest Department has been reluctant to use prescribed fire, but they are slowly gaining interest.

The Future of Fire Management in Israel

During our trip to Israel, we identified several opportunities for improving the fire program. The Forest Department is anxious to implement changes in their program before the 1988 fire season. A delegation from the Forest Department will visit the United States during the spring of 1988 to review selected aspects of fire management programs in Regions 5 and 8 of the USDA Forest Service and to develop an action plan for implementing strategies. We anticipate a close working relationship with the Forest Department in the years to come. ■

Let's Stop Fighting Forest Fires

William B. Martini

Director, North East Area Training Center, Tomahawk, WI

The training of thousands of people nationwide in the skills and knowledge needed to put out forest fires is a huge, important, and expensive endeavor.

Locally Organized Training

For many years, State and Federal fire agencies all trained their "own" people in their own methods. There was little cooperation and no uniformity. Training standards, methods, and qualifications varied widely. Agencies developed training courses at high costs that closely duplicated courses already developed. Training was presented in a classroom half full of students, while a few miles away, the same course was being given in another half-full classroom. Little effort went into sharing, consolidating, or preventing duplication of effort.

Wildland fire agencies were fiercely independent. They were concerned only with success in their own jurisdiction. While this was happening nationwide, serious forest fires were increasing. People were building homes in what was once considered strictly forest land or wildland.

Environmental attitudes were also changing. Fires that once were considered "only grass or brush fires" were becoming a deep concern to many citizens who previously said, "Who cares, it was only a brush fire."

Merger of Resources

Politically, there was a cost-cutting epidemic that proposed elimination of some resource agencies and merger of others. It was being suggested that some Federal resource and fire management agencies could be merged into one large nationwide resource management agency—a Federal Department of Natural Resources. The question, "Why couldn't the U.S. Department of Agriculture's Forest Service, or the U.S. Department of the Interior's Bureau of Land Management, Fish and Wildlife Service, National Park Service, and Bureau of Indian Affairs, who all do similar fire and resource management work, be combined?" was being discussed.

Proposals along these lines were of great concern to the fire managers in these agencies. Many advocated "getting our act together" or somebody would do it for us. In addition, sharing of training ideas, talent, courses, facilities, and standards made economic sense. Duplication of effort and waste bothered all trainers, regardless of a threat of reorganization.

In 1973, all of the Federal and State fire organizations decided to do something about this problem. They met and formed the National Wildfire Coordinating Group (NWCG).

One of the first needs identified by the NWCG was to establish uniform fire training. A National Fire Training Working team was formed. This team was chartered to work on coordination, sharing, and development of standard fire training and qualifications nationwide.

The first project of the training team was to develop a standard, uniform set of training courses aimed at the suppression of wildland fires. These courses were to be designed for use by all 50 States and all Federal fire agencies. This was an enormous undertaking, but it was agreed that it was of highest priority. The next priority for training was intended to be the prevention of wildland fires.

In the following 10-year period, many excellent courses were developed and distributed. Most were targeted on fire suppression. They are called the "S" (suppression) courses and were coupled with a Federal qualification system (Red Cards).

As an outgrowth of this effort came the adoption of the National Interagency Incident Management System of NIIMS. The "old" fire courses of the Large Fire Organization were altered to fit NIIMS terminology and methods of managing fires and other incidents. Many new courses were developed and distributed.

Development of Fire Prevention Programs

At this time, many fire agencies are switching from major emphasis on suppressing wild fires to preventing them. Although this change in attitudes and policy adds an important dimension to wildland fire programs, the shift in effort creates some problems. Quality courses to train a person to conduct an effective wildland fire prevention program do not exist.

Motivating people to do prevention work is more difficult than training them to do the more dramatic and glamorous work of fire suppression.

The results and rewards of a good job in prevention are also more difficult to evaluate and measure. When a major fire is stopped, the victors are applauded. They then gear up for the next fire and this drama goes on and on. Suppression skills are easier to teach and proficiency in these skills can quickly become evident. The fire was effectively and rapidly contained or it grew into a disastrous tragedy. Efforts expended in prevention are slow to apply and difficult to assess and justify. The skills and knowledge needed are likewise harder to teach and apply.

To start work on a fire prevention training program, 20 States funded a program to assist in the development of training targeted on how to plan and implement a sophisticated, effective prevention campaign. The organization they formed is called the North East Area Training Center (NEAT). It is based at Tomahawk, WI. It is hosted by and uses the facilities of the Wisconsin Department of Natural Resources.

The NEAT organization is striving to accomplish some badly needed fire training goals:

- Provide input and assistance to fire course development to meet Northeastern States (20 States of the Northeastern Area State and Private Forestry) training needs.
- Maintain cooperation and communication with other fire training organizations such as Northeastern Area State and Private Forestry; National Training Team of NWCG; Boise Interagency Fire Center; Northeastern, Great Lakes, Middle Atlantic, Southeastern, and South Central Fire Compacts; California Department of Forestry and Fire Protection Fire Academy, National Fire Academy, and others devoting effort to fire training.
- Compile and maintain a list of fire training officers of the Northeastern States.
- Collect fire training materials, list these in a catalog, and distribute information to the Northeastern States.
- Locate and distribute lists of courses being offered, subject matter experts, and qualified fire instructors.

Many fire prevention courses are being considered and developed. The organization is 2 years old and has had enthusiastic support from the agencies it serves. This is one example of how the wildland fire community is trying to change an old attitude of suppressing fires to preventing them. People interested in the threat of wildfires to our Nation's resources should consider some intriguing questions:

- Why is the arson rate in our forests and wildlands on a nationwide increase? (Is skyrocketing wildland arson connected to the terrorist mania?)
- Is it cheaper and more efficient to prevent a forest fire or to put one out?
- Is it true or possible that almost all wildland fires are preventable?
- Are wildland fire agencies spending as much on prevention training as they are on fire suppression?
- Is it feasible to have volunteer citizen arson patrols protecting our wildland resources?
- Is it possible to catch and convict most arsonists?

I think that training as many people as possible in the skills needed to prevent fires is the only way to find the answers to these questions. How long can we continue to neglect fire prevention training when our resources are being burned at an alarming rate? Almost all fires are started by humans. The majority of fires are caused by irresponsible acts or, worse, set intentionally.

With budget cuts promised, fire agencies must become more efficient by training people to practice fire prevention or learn to live with a burned resource.

Let's stop fighting forest fires and start training to prevent them. ■

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